WORKING PAPER SERIES 1-2016

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Market and Political Power Interactions in Greece: A Theory

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February 2, 2016

Abstract: In recent years the growth pattern of Greece has been disturbed, as this country is suffering from a persisting economic crisis that goes beyond the usual business cycle. In this paper, we develop a neoclassical growth model of market and political power interactions that explains this crisis. The model incorporates the insiders-outsiders labor market structure and the concept of an elite government. Outsiders form a group of workers that supply labor to a competitive private sector. And, insiders form a group of workers that enjoy market power in supplying labor to the public sector and influence the policy decisions of government, including those that affect the development and maintenance of public sector infrastructures. This leads to labor misallocation and inefficient fiscal policies. Despite the fact that expanding public sector output has a positive effect on growth, eventually this is counterbalanced by the labor misallocation and inefficient tax policy outcomes. Thus, the deep and sustained growth reversal occurring in Greece is explained as a consequence of the organizational structure of the labor market, that has important implications on the workings of the economic and political systems.

JEL classification: P16; O43; J45; O52
Keywords: Insiders - Outsiders; Politicoeconomic Equilibrium; Taxation; Fiscal Policy; Growth; Greek Crisis

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“Too many politicians and economists blame austerity – urged by Greece’s creditors – for the collapse of the Greek economy. But the data show neither marked austerity by historical standards nor government cutbacks severe enough to explain the huge job losses. What the data do show are economic ills rooted in the values and beliefs of Greek society. Greece’s public sector is rife with clientelism (to gain votes) and cronyism (to gain favors) – far more so than in other parts of Europe”.

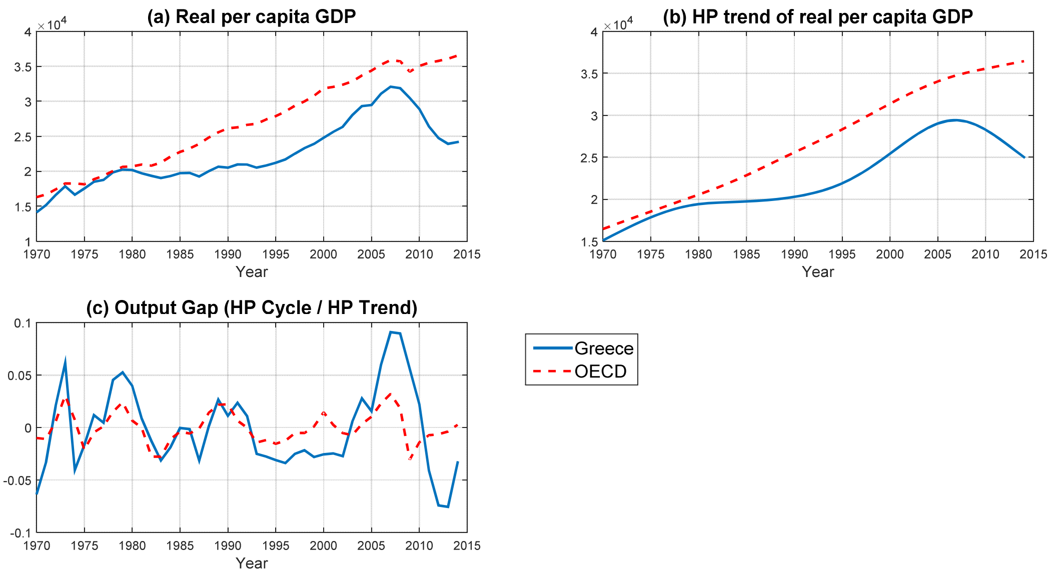
Edmund S. Phelps, 2006 Nobel laureate in Economics*

*Project Syndicate, September 4, 2015. Link: http://www.project-syndicate.org/columnist/edmund-s--phelps.

1. INTRODUCTION

In recent years the growth pattern of Greece has been disturbed, as this country is suffering from a persisting economic crisis that goes beyond the usual business cycle. As Figure 1(a) makes clear, there is a divergence in the GDP per capita path of Greece relative to that of the OECD average, since the early eighties.[1,] This divergence is apparent in both the long term growth and business cycle components, illustrated in Figures 1(b) and 1(c), respectively, whereby the HP filter trend and cyclical components of real per capita GDP are plotted for Greece and the OECD average. More strikingly, the recent recession plaguing most OECD countries over the last eight years has been considerably more severe in Greece, where even long term growth has declined dramatically. So, the obvious questions are: Why are these phenomena happening? And, how can they be restrained? Since the economics profession largely regards the Greek crisis as a sovereign debt crisis characterized by an unprecedented output loss, these questions could be rephrased as: Why did the sovereign debt crisis come about in the first place and why was it so severe in Greece?[2] As a starting point, we should accept that answers to these questions cannot be found but in a theory that is consistent with the underlying structure of the Greek economy.

Figure 1. Greece versus the OECD average (1970-2014)



The structure of the economic and political systems of Greece is characterized by a relatively large public sector, with basic networks and utility services provided by government and more importantly by agencies or firms that, on the one hand, are heavily regulated and, on the other hand,

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[1] A similar divergence emerges when comparing Greece with the Eurozone average (See Data Appendix). The dismal growth performance of Greece has been documented in a number of studies, including: Alogoskoufis (1995), Bosworth and Kollintzas (2001), Kollintzas, et al (2012), Gogos, et al (2014).

[2] Blanchard (2015), for example, writes: "Even before the 2010 (first bailout) program, debt in Greece was 300 billion euros, or 130% of GDP. The deficit was 36 billion euros, or 15½ % of GDP. Debt was increasing at 12% a year, and this was clearly unsustainable". For a narrative of the Greek crisis see also Bulow and Rogoff (2015).

labor therein is organized in powerful independent unions.[3,4] Moreover, there are important strategic interactions between these unions and the government that create a bias for high spending and consequently for high taxes and high debt accumulation.[5]

In this paper, we develop a dynamic general equilibrium model of market and political power interactions, based on a synthesis of the insiders-outsiders labor market structure of Lindbeck and Snower (1986) and the concept of an elite government of Acemoglu (2006), as this elite coincides with the group of insiders. That is, we identify insiders as a group of workers that enjoy market power in supplying labor to the public sector and influence the policy decisions of government, including those that affect public finances through the development and maintenance of public sector infrastructures. And, we identify outsiders as a group of workers that supply labor to a competitive private sector. Thus, wages differ across identical labor services due to the particular organization of the labor market.[6] Although insiders and outsiders are identical, the wages of insiders are higher than those of the outsiders, creating, what we call the "labor misallocation effect," that lowers output and output growth towards the steady state.

More specifically, outsiders work on the production of a final good, while insiders work on the production of intermediate goods, produced by monopolies controlled by government. For that reason, intermediate goods enter the final goods production function through a Dixit-Stiglitz aggregator that incorporates the so called "variety" effect, whereby an increase in the number of intermediate goods increases output. Further, this aggregator allows for intermediate goods to be gross complements, as one should think of the services of various network infrastructures, provided by the State (e.g., power, water, phone, roads, railways, harbors, airports, etc.). Thus, by construction, public sector involvement is prima facie beneficial for growth. Nevertheless, and in anticipation of the results of the model, this feature does not prevent public sector expansion being detrimental to growth.

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[3] Total government spending as a share to GDP in the pre-crisis year 2007 in Greece was 46.93%. This is not much higher relative to the Eurozone 15 average of 45.33, but considerably than the OECD average of 39.01. However, it is not so much the size of the government that is in question, here, but the fact that the Greek state is widely taken to be one of the most interfering in the workings of the economy (See, e.g., the 2015 OECD study by Koske, et al.).

[4] Chapter 1 of the "Industrial Relations in Europe 2012" extensive report of the European Commission (2013) places Greece along with other Southern European countries in the industrial relations system cluster, referred to as "state-centered." And, in Chapter 3, the same cluster of countries is identified when it comes to public sector industrial relations. Similar classifications with respect to wage bargaining institutions have been made in Visser (2013) and European Commission (2014).

[5] This interaction has been recognized in the political science literature since the late seventies (Schmitter (1977), Sargent (1985), Cawson (1986)) and recently has been explicitly pointed out for Greece by Featherstone (2008).

[6] In the insiders-outsiders theory of Lindbeck and Snower (1986), some worker participants ("insiders") have privileged positions relative to others ("outsiders"). Insiders get market power by resisting competition in a variety of ways, including harassing firms and outsiders that try to hire/be hired, by underbidding the wages of insiders and by influencing pertinent legislation (Saint-Paul (1996)). There has been no association of the wage premium in the public sector and insiders-outsiders labor market, to our knowledge, in the literature. However, the importance of insiders-outsiders labor markets for providing the microeconomic foundations for justifying the strength of unions has been at the core of this literature (see, e.g., the survey by Lindbeck and Snower (2001)). As already mentioned, in the previous footnote, the strength of the unions in the public sector in the South European countries has been noticed in the political science literature.

The wage rate of outsiders is determined competitively. Each intermediate good producer prices its output satisfying a zero profit condition, taking the wage rate offered by the corresponding insiders' union as given. This determines each intermediate good producer's employment and output. Then, the corresponding wage rate is determined by the respective union that takes the demand for labor it faces, as given. This is the well known Monopoly-Union model of McDonald and Solow (1981) and Oswald (1983). Since there are as many independent unions of insiders as there are intermediate good producers, overall equilibrium in the market for insiders' labor is characterized by a Nash equilibrium among all insiders' unions. This modeling choice is, again, consistent with Greek labor market institutions, as well as those of other Southern European countries, where the wage setting process in the public sector is characterized by trade union fragmentation and, at the same time, lack of co-ordination.[7] This is quite different from other typically identified country clusters. For example, in Anglo-Saxon countries wage bargaining is thought, in general, to be competitive and labor unions are thought to play a relatively small role in wage setting. On the other hand, in the Nordic countries, labor unions in all sectors are thought to be powerful but cooperative, thereby internalizing the externalities associated with a high wage premium of one industry/sector on the rest.[8]

In the symmetric equilibrium case, given reasonable parameter restrictions, the ratio of the wage rate of insiders over that of the outsiders (i.e., the public sector wage premium) is greater than one and increasing in the degree intermediate goods are gross complements, as well as in the number of publicly provided intermediate goods. Moreover, the wage premium and the ratio of employment in the public sector over total employment are inversely related, giving rise to the "labor misallocation effect". For a fixed number of insiders' unions, this model is formally equivalent to a standard Cass-Koopmans neoclassical growth model, where Total Factor Productivity (TFP) declines with the wage premium, but increases with the number of intermediate goods, as the "variety" effect dominates over the "labor misallocation" effect. However, the overall effects on steady state capital, output and growth towards the steady state, depend on the after-tax labor productivity. For it is assumed that the underlying infrastructure, associated with the publicly provided intermediate goods, is financed by a distortionary income tax. Then, it is shown that the effect of an increase in the number of publicly provided intermediate goods on steady state output and growth towards this steady state is negative (positive), depending on the existing number of publicly provided intermediate goods. If this number is higher or lower than a certain threshold, the combination of the "labor misallocation" and the tax distortion effects dominates over (is dominated by) the "variety" effect. All this being quite plausible, as the "variety" effect decreases, and the

[7] See Sections 3.5.2 and 3.9 in European Commission (2013) and European Commission (2014).
[8] See Visser (2013).

"labor misallocation" and tax distortion effects both increase with the existing number of publicly provided intermediate goods, i.e., public sector expansion.

Further, if the number of publicly provided intermediate goods is allowed to vary, each group of insiders union realizes that it has a common interest with all other groups of insiders unions in controlling/influencing the number of publicly provided intermediate goods. Hence, it is to the interest of all insiders' unions to cooperate so as to control/influence government and its budget. For that matter, we consider a politicoeconomic equilibrium defined as the solution to the problem of a government, seeking to maximize an objective function, that to some degree is influenced by representative household preferences and is likewise influenced by insiders' unions preferences. This maximization is subject to the underlying economic equilibrium and the government budget constraint. Under plausible restrictions, we prove that such a politicoeconomic equilibrium exists and is characterized by a steady state which is globally asymptotically stable. Moreover, it is shown that such politicoeconomic equilibrium will be characterized by a number of publicly provided intermediate goods that is greater the greater is the influence of insiders. This, in turn, implies that such a politicoeconomic equilibrium will be supported by a higher (distortionary) income tax rate and/or debt level, the greater is the influence of insiders. This is the "political effect" that, depending on the number of publicly provided intermediate goods, may further reduce steady state capital, output, and output growth towards the steady state. It follows, therefore, that, to the degree that the political and economic system of a country is like the insiders-outsiders society of this model, it would exhibit a relatively high wage premium in the public sector, low public to total employment ratio, and lower steady state after-tax total factor productivity, capital, output and growth towards this steady state.

So we have two results: First, a government influenced by insiders will choose a higher number of publicly provided intermediate goods and second, after-tax total factor productivity rises or falls depending on whether this number is lower or higher than a certain threshold. It is the combination of these two results, that leads to the model's prediction that countries which behave sufficiently close to an insiders – outsiders society: First, will have a lower steady state growth, and second, in what concerns transition towards this steady state, although they may enjoy relatively high growth early on, will eventually suffer from a growth reversal.

Hence, following the potential growth reversal outcome predicted by our model, we view the Greek crisis as a consequence of the insiders-outsiders organization of society. Since debt could be easily introduced in this model, without affecting the qualitative results, our model has also implications for the unsustainable Greek sovereign debt.[9] First, obviously, a growth reversal would

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[9] A taxation-debt channel could be introduced in a number of ways. For example, it can be easily verified that, in a small open economy version of our model, whereby borrowing interest rates are an increasing function of the outstanding debt to GDP ratio, there will be a uniquely determined steady state of this ratio. And, an increase in the

increase the debt to GDP ratio by reducing the denominator. Second, the growth reversal itself is driven by the dominance of the labor misallocation and tax distortion effects over the growth enhancing effect of public sector expansion. This dominance is driven by higher taxes needed to finance the expansion and maintenance of public sector infrastructures that will ensure and provide for high wages in the public sector. For an economy that lies on the "slippery" side of the Laffer curve, as Greece seems to be, this would imply an increase in debt.[10] Consequently, an insiders-outsiders society will further increase the debt to GDP ratio by increasing the numerator.

The results of this paper relate to several different strands of the literature on political economy, public finance, growth and European integration. First, it relates to the rent seeking / special interests political economy literature. In particular, it incorporates two basic ideas of that literature. First, that insiders seek rents from the political system for their own benefit and that the agents of the political system accommodate these demands in pursuit of their economic and political goals. Second, that, once the political system allows it, rent seekers are formed in groups, so as to take advantage of their common interests in rent seeking, by controlling/influencing government.[11] Also, it shares with the recent political economy and economic growth literature, the idea that resources devoted to rent seeking are ultimately detrimental to growth.[12]

Second, it relates to the unifying theory of Acemoglu (2006) who develops a general framework for analyzing the growth implications of politicoeconomic equilibria. Considering three groups of agents: workers, "elite" producers and "middle class" producers. Elite producers control the government and tax middle class producers through a distorting income tax and distribute the proceeds among themselves via a lump-sum transfer. [13] We share with Acemoglu (2006) both the

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number of publicly provided intermediate goods will lead to an increase in this debt ratio, as well as the income tax. The proportion of tax to debt financing will depend on the rate at which interest rates increase with the debt do GDP ratio. We do not pursue this extension here, since this would have come to the cost of sacrificing the analytic results on growth.

[10] Trabandt and Uhlig (2010) and Bi and Traum (2014)) find that this is the case for the Greek economy.

[11] The idea that the various beneficiaries of government policies are more likely to get politically organized, whereas the interests of the un-organized general public are neglected is found in the pioneering works of Schattschneider (1935), Tullock (2010), Olson (1965), Weingast et al. (1981) and Becker (1983, 1985).

[12] See Parente and Prescott (1994), Krusell and Rios Rull (1996), Aghion and Howitt (1998), Angeletos and Kollintzas (2000), Grossman and Helpman (2002), Acemoglu and Robinson (2008) and Acemoglu (2006, 2009 Chapters 22, 23).

[13] Acemoglu's motives for increasing the distorting tax are three: (a) "Revenue extraction": the provision of resources for the benefit of the elite; (b) "Factor price manipulation": the lowering of factor prices used in the elite's production process; and (c) "Political consolidation": the impoverishment of middle class producers, so as to prevent them from acquiring the resources necessary to achieve political power. To anticipate the workings of our model, we may think of insiders as acting according to Acemoglu's three motives. The first and the third of these motives for increasing the distorting income tax, are captured by the need for the maintenance of the existing (old) and the creation of the new publicly provided infrastructure that ensures the funding for their employers businesses. The second motive is captured by the fact that an increase in the income tax rate, increases the user cost of capital and the wage rate of outsiders, lowering the demand for these factors and increasing the demand for services of intermediate good products. This, in turn, increases the demand for insiders' labor, in such a way so as to increase the wage premium in the public sector. Like in Acemoglu, it is this effect that seems to be the most damaging for the economy. However, there are important differences between Acemoglu's framework and the one developed herein. First, the roles of "elite entrepreneurs" and "middle class entrepreneurs" are taken, here, by "insiders" and "outsiders", that they are both workers. Second, since insiders are organized in unions, that set the wage rate, there is an additional distortion in our model's economy over

strategic interactions in solving for a politicoeconomic equilibrium, as well as the notion of the "political elite". The latter is taken to make the political decisions and engage in economic activities. In our case, the political elite consists of the members of insiders' unions.

Third, it relates to the literature on models that distinguish between public and private employment, focusing on public-private wage determination. Forni and Giordano (2003) consider a static model of private and public sector wage determination. In their model there are many public and private firms and two unions representing public and private sector employees. They consider a variety of solutions for the game between the two unions and the firms. Our model shares with one of their solution concepts- that of a "fragmented government" – the notion that government consists of a variety of independent firms. There is also a number of dynamic general equilibrium models that examine the behavior of public and private sector wages over the business cycle (e.g., Ardagna (2007), Fernandez de Cordoba, et al. (2012)). Typically in this literature, wages in the public sector are determined as the outcome of a non-cooperative game between the union of public sector employees and a government that cares about total employment. As in this literature, our model has a key role for the public sector wage premium. However, we have chosen to determine this premium following the "cartel sector" model of Cole and Ohanian (2004) whereby labor is divided between groups of insiders and outsiders. And, as already noted, insiders and outsiders work for public (cartel) and private (competitive) sector firms, respectively, while government is influenced by insiders in setting public policies.

Fourth, it relates to the "varieties of capitalism" literature of political science, pioneered by Hall and Soskice (2001), as well as Esping-Andersen's (1990) "three worlds of welfare capitalism" social model analysis. In this literature, it has been suggested that Greece as well as other Southern European countries have their own "variety" of capitalism, where the state plays a major role (see, e.g., Molina and Rhodes (2007) and Featherstone (2008)). In a sense, the insiders-outsiders society idea is based on the institutional complementarity between market organizations, where the wage premium favors individual groups of society ("insiders") and the political system, where these groups control or influence government, for insiders' collective benefit. As already noted, this interaction has been emphasized on another strand of the political science literature, namely, that on "neo-corporatism" (Schmitter (1977), Sargent (1985), Cawson (1986)).

Finally, our results should be of interest to the European integration question. Countries that have gone beyond a certain point toward the insiders-outsiders society, as Greece and possibly other Southern European countries might have, will experience difficulties following the others in after-

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and above the tax distortion. This additional distortion strengthens the "factor price manipulation" effect. Third, there is a fundamental nonlinearity, as an increase in the distorting tax rate, so as to increase the number of publicly provided intermediate goods, may be beneficial for the economy, if the number of existing publicly provided intermediate goods is relatively low and the opposite may be true, if the existing number of those goods is relatively high.

tax TFP growth.[14] This outcome has already been suggested by several policy influential economists (see, e.g., Blanchard (2004), Alesina and Giavazzi (2004)).

The rest of the paper is organized as follows: Section 2 develops the model. Section 3 establishes the main results of the paper. Section 4 discusses the model's explanation of the growth reversal and the stylized facts mentioned above and Section 5 concludes.

2. MODEL

Time is discrete and there is no uncertainty. The economy consists of a large number of identical households whose members supply labor and capital services and consume a final good. This final good can either be consumed or invested and is produced by means of physical capital and labor services, as well as, the services of a number of intermediate goods provided by government. Household labor consists of two kinds: Labor supplied to the final good producers in a competitive market and labor supplied to the publicly provided intermediate goods through independent monopolistic labor unions. Moreover, these monopolistic unions cooperate in controlling/influencing all government policies. Household members supplying their labor competitively will be referred to as "outsiders" and household members supplying their labor through labor unions will be referred to as "insiders." And, the model economy will be referred to as the "insiders-outsiders society."

2.1. Households and Firms

Household preferences are characterized by a standard time separable lifetime utility function of the form $U^h = \sum_{t=0}^{\infty} \beta^t \frac{c^{1-\gamma} - 1}{1-\gamma}$ where: $\beta \in (0,1)$ is the household discount factor, c_t is consumption per capita in period *t*, and $1/\gamma \in (0,\infty)$ is the constant elasticity of intertemporal substitution. Households own physical capital, that depreciates according to a fixed geometric depreciation rate, $\delta \in (0,1]$ and evolves according to $k_{t+1} = (1-\delta)k_t + i_t$, where k_t is capital stock at the beginning of period *t* and i_t is gross investment in period *t*. In every period *t*, each household has available a fixed amount of labor time, $\overline{h} \in (0,\infty)$, that can be allocated to the production of the final good, h_t^o, and the production of services from a continuum of intermediate goods, $[0, N_t]$, provided by government. Thus, the time constraint of each household, in every period *t*, is given by:

[14] For Greece, this has been argued in Kollintzas, et al. (2012). Kollintzas, et al. 2015, present evidence for the presence of insider-outsider society characteristics in other Southern European countries, as well.

$$h_t^o + \int_0^{N_t} h_t^i(z)\,dz \;\; \leq \bar{h} \tag{1}$$

where: $h_t^i(z)$ is labor time devoted by each household to the production of services from the z intermediate good, in period t.

Although our formulation of households allocating time among final and intermediate good sectors is admittedly a highly schematic one, as already mentioned, the reader may think of households having many members, where some are “insiders” and others are “outsiders.” As will be made apparent below, the numbers of insiders and outsiders in our model are determined by the demand side (firms and unions), exclusively. Allowing insiders’ layoffs, as in Cole and Ohanian (2004), could determine the numbers of insiders and outsiders by the supply side (households), as well. For tractability purposes, we have chosen not to pursue this extension here. At any rate, in our model, as well as in Cole and Ohanian (2004), there is perfect household insurance among household members, whether insiders or outsiders. Hence, the profoundly important income distribution effects of the insiders–outsiders society are, consequently, ignored. And, as is, of course, the important question of who chooses to become an insider and who ends up as an outsider, in the presence of these income distribution effects.

The budget constraint facing each household, in any given period t, is given by:

$$c_t + k_{t+1} - (1-\delta)k_t = (1-\tau_t)\left[r_t k_t + w_t^o h_t^o + \int_0^{N_t} w_t^i(z) h_t^i(z)\,dz \right] \tag{2}$$

where: τ_t is the income tax rate in period t, r_t is the rental rate of capital services in period t, w_t^o is the wage rate for labor time devoted to the production of the final good, $w_t^i(z)$ is the wage rate for labor time devoted to the production of services from the z intermediate good, in period t.

The representative household seeks a consumption, capital accumulation and time allocation plan so as to maximize lifetime utility, subject to the time and budget constraints, (1) and (2), respectively. In so doing, the representative household takes all prices, income tax rates, and numbers of intermediate goods, as given.[15]

In view of the functional form of the temporal utility function, specified above, necessary and sufficient conditions for a solution to the problem of the representative household are the standard side conditions along with the Euler condition:

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[15] Obviously, if $w_t^i(z)$ is different from w_t^0, the household will not be indifferent between h_t^0 and $h_t^i(z)$. If, for example, $w_t^i(z')$, for some z', is greater than w_t^0, the household would prefer $h_t^i(z')$ over h_t^0. Likewise, if $w_t^i(z')$ is greater than $w_t^i(z'')$, for any given z' and z'', the household would prefer $h_t^i(z')$ over $h_t^i(z'')$. In any case, in the solution to the household’s problem, (1) will hold with equality. Later, h_t^0 and $\left\{h_t^i(z)\right\}_{z\in[0,N_t]}$ will be set following demand conditions and institutional constraints, without violating household incentives.

$$\frac{c_{t+1}}{c_t}=\{\beta[(1-\delta)+(1-\tau_{t+1})r_{t+1}\}^{\frac{1}{\gamma}};\forall t\in\mathbb{N}_+ \tag{3}$$

Production in the final good sector takes place in a large number of identical firms. The production technology of the representative firm in this sector is:

$$Y_t = K_t^a(A_tL_t^0)^b\left[\int_0^{N_t} x_t(z)^{\zeta}dz\right]^{\frac{1-a-b}{\zeta}};\quad a,b>0,\ a+b<1\ \&\ \zeta\in(0,1] \tag{4}$$

where: Y_t is output supplied in period *t*, K_t is physical capital services used in period *t*, L_t^0 is labor services used in period *t*, A_t is a parameter that designates the level of (Harrod–neutral) technology at the beginning of period *t* and grows according to: $A_{t+1}=(1+g_A)A_t$, $g_A\in[0,\infty)$; and $x_t(z)$ is the services from the *z* intermediate good used in period *t*. The RHS of (4) is a constant returns to scale production function. The Dixit-Stiglitz aggregator is used to model the composite of all intermediate good inputs, $\left[\int_0^{N_t} x_t(z)^{\zeta}dz\right]^{(1/\zeta)}$, in a tractable manner. Thus, we assume that there is a continuum of intermediate good products and that N_t is a positive real number.[16] Restricting $\zeta\in(0,1]$ ensures that output increases with the number of intermediate goods, so as to capture the so called "variety" effect, introduced by Romer (1990).

Although we think of intermediate goods as goods provided by government, we do not think of these goods as pure public goods. In particular, we think of intermediate goods as being excludable, in the sense that only those final good producers that pay for using the services from a given intermediate good can use those services. Moreover, these goods are not necessarily non-rival, in the sense that a final good producer that uses the services from a given intermediate good may or may not limit the amount of services used by other final good producers. Actually, most publicly provided services are excludable and to a great extend rival. For example, in many countries basic utilities (electrical power, water and sewage, garbage and waste collection and disposal, stationary telephony and natural gas), transportation networks (railroads, harbors, airports), and various licenses (foods and drugs, fire and flood safety) are provided to their users for a price.

[16] It can be easily verified that this aggregator belongs to the CES family of production functions, in that it exhibits constant elasticity of substitution across intermediate goods. That is, the elasticity of substitution between any two intermediate goods is $\sigma=\frac{1}{1-\zeta}$. Thus, for $\zeta\to 1$, $\sigma\to+\infty$, in which case intermediate goods are perfect substitutes and for $\zeta\to-\infty$, $\sigma\to 0$, in which case, intermediate goods are perfect complements. For $\zeta<1-a-b$ ($\zeta>1-a-b$) intermediate goods are gross complements (gross substitutes). For $\zeta=1-a-b$, the aggregator becomes as in Romer (1990), where the marginal productivity of any given intermediate good is not affected by the input of any other intermediate good. That is, $[\partial^2 Y_t/\partial x_t(z')\partial x_t(z'')]\overset{>}{\underset{<}{=}}0$ as $\zeta\overset{<}{\underset{>}{=}}1-a-b$; $\forall z',z''\in[0,N_t]\ni z'\neq z''$.

Cole and Ohanian (2004), in their seminal paper, where they examine the effects of New Deal policies on the recovery from the Great Depression in the United States, consider two kinds of intermediate goods sectors. In their model, labor is supplied to two sectors: the noncompetitive "cartel" sector and the "competitive" sector, much like in our formulation, but in their model government policies are exogenous. Further, the number of intermediate good products (varieties) in their formulation, is taken to be fixed and only the distribution of those products between the two sectors is endogenously determined. We have opted to consider publicly provided intermediate goods only, for as already said, we are motivated by Greek macroeconomic and political structures, where the state plays a major role and the number (varieties) of publicly provided intermediate goods products may have been an important contributor to growth. And, obviously, the way the variety effect is modeled, here, gives an incentive for expanding the public sector via the increase of the number of publicly provided intermediate goods, N_t.[17]

Let $p_t(z)$ be the price for the services of the *z* intermediate good in period *t*. At the beginning of any given period *t*, the representative final good producer, maximizes profits:

$$\pi_t^y = K_t^a (A_t L_t^0)^b \left[\int_0^{N_t} x_t(z)^{\zeta} dz \right]^{\frac{1-a-b}{\zeta}} - r_t K_t - w_t^0 L_t^0 - \int_0^{N_t} p_t(z) x_t(z) dz \,, \tag{5}$$

taking all input prices and the number of intermediate good producers as given.

The (inverse) demand for the services from the *z* intermediate good is:

$$(1-a-b) K^a (A_t L_t^0)^b \left[\int_0^{N_t} x_t(z')^{\zeta} dz' \right]^{\frac{1-\alpha-b-\zeta}{\zeta}} x_t(z)^{\zeta-1} = p_t(z); \; \forall z \in [0, N_t]. \tag{6}$$

Demand increases (decreases) with the composite of all intermediate good inputs, $\left[\int_0^{N_t} x_t(z')^{\zeta} dz' \right]^{(1/\zeta)}$ or, for that matter, with any given intermediate good $z' \in [0, N_t]$, if and only if $\zeta < 1-a-b$ ($\zeta > 1-a-b$). That is, if and only if intermediate goods are gross complements (gross substitutes). Clearly, however, gross complementarity is more compatible with the idea of public intermediate goods being basic utilities, transportation networks, licenses, etc. Therefore, throughout, we shall maintain the assumption that intermediate goods are gross complements:

***Assumption 1*:** $1-\alpha-b-\zeta > 0$

[17] A generalization of the model that includes privately provided intermediate goods, as well, is straightforward, along the lines of Cole and Ohanian (2004). Such an extension would make the model much richer and allow us to address additional questions such as the effects of complementarity or substitutability in production among the private and the public sectors, as well as new aspects stemming from the strategic interaction of private and public sector unions (see also the discussion in the end of section 4). This, however, also comes at a cost of increasing considerably the model's complexity and, consequently, preventing analytical results.

As the infrastructure associated with each intermediate good is provided by government, the services of intermediate goods are produced by using labor only:

$$X_t\,(z) = \Phi(z)\,A_t L_t^i(z);\ \Phi(z) \in (0,\infty),\ \forall z \in [0, N_t)\ \&\ t \in \mathbb{N}_+ \tag{7}$$

where: $X_t\,(z)$ is output supplied in period t and $L_t^i(z)$ is labor services used in period t.

In any given period *t*, the representative producer of services from the *z* intermediate good chooses labor input, so as to achieve zero profits: [18]

$$\pi_t^x(z) = p_t\,(z)\,X_t(z) - w_t^i(z) L_t^i(z) = 0\,, \tag{8}$$

taking the production technology constraint (7), the demand for its services (6), the number of intermediate good producers, the labor input choices of all other intermediate good producers and wages as given. This gives the following (inverse) aggregate demand for labor in the production of services from the *z* intermediate good:

$$(1-a-b)A_t^{1-a} K_t^{\alpha} L_t^{0b} \left\{ \int_0^{N_t} [\Phi(z')L_t^i(z')]^{\zeta}\, dz' \right\}^{\frac{1-\alpha-b-\zeta}{\zeta}} \Phi(z)^{\zeta}\, L_t^i(z)^{\zeta-1} = w_t^i(z) \tag{9}$$

Clearly, given Assumption 1, this demand increases with the weighted average of the labor input in the production of services of all intermediate goods, $\left\{ \int_0^{N_t} [\Phi(z')L_t^i(z')]^{\zeta}\, dz' \right\}^{\frac{1}{\zeta}}$. [19] This formulation is consistent with Greek experience, where public utilities, transportation networks, and other publicly provided services are supplied by a single agency/firm that has a monopoly, but is heavily regulated. However, these agencies/firms end up behaving like unregulated monopolist, due to the behavior of the union that controls their labor input.[20] And this is the model feature we turn next.

2.2 Insiders' Unions

Labor used in the production of services from each intermediate good *z* is organized in a union. That is, there is a separate union *z* for each intermediate good *z*, for all *z*. We refer to these unions as "insiders' unions." Following the standard union literature, we assume that the preferences of the *z* union of insiders are characterized by the utility function

[18] This is not a crucial assumption and the propositions of this paper would go through with publicly provided intermediate good service producers having some other objective, like regulated profits. For simplicity purposes, this is not pursued in this paper.

[19] The number of final good producers is irrelevant, in this model, due to the CRS production function in (4) and perfect competition. Moreover, the number of *z* intermediate good service producers is also irrelevant due to the CRS production function in (7) and the zero profit restriction. Thus, without loss of generality, (9) has been expressed in representative final good producers units.

[20] A classic example is the Greek Power Company (ΔΕΗ), which although a de facto monopoly, has more or less zero profits, but its labor union (ΓΕΝΟΠ-ΔΕΗ) has substantial market and political power, that results in substantial wage premiums and other benefits for its members (See, e.g., Michas (2011), for a narrative).

$U^i(z) = \sum_{t=0}^{\infty} \beta^t \ln\left[w_t^i(z) - w_t^0\right]^{\lambda(z)} L_t^i(z)$, where $\lambda(z) \in (0,1)$, $\forall z \in [0, N_t]$ and $t \in \mathbb{N}_+$. This form of union preferences corresponds to the "utilitarian" model of McDonald and Solow (1981) and Oswald (1982), where the representative union member has a constant relative rate of risk aversion, provided that union membership is fixed. Here, union membership is determined by the union and is fixed and equal to employment in the production of services of the corresponding intermediate good sector. Further, w_t^0 is the "alternative wage" for insiders, in the sense that, $w_t^i(z) - w_t^0$ is the wage premium of insiders over outsiders and at the same time the wage premium in the public sector. The latter, as already noted, are all those that work in the final good sector of the economy. And, finally, $\lambda(z)$ is a parameter that measures the relative preference of the wage premium over employment for the *z* union of insiders. As usual, we take $\lambda(z)$ to stand for a measure of the union's relative bargaining power.

At the beginning of any given period *t*, the *z* union of insiders seeks a wage and employment plan so as to maximize its utility, subject to the aggregate demand for labor in the production of services from the *z* intermediate good (9); and, the institutional constraint: $L_t^i(z) > 0$, if and only if $w_t^i(z) > w_t^o$; $\forall z \in [0, N_t]$ & $\forall t \in \mathbb{N}_+$. In so doing, the *z* union of insiders takes the aggregate capital, the aggregate employment of outsiders, the wage and employment choices of all other unions of insiders and the number of intermediate good producers, as given.

Let $\eta_t(z) \equiv -\frac{\partial L_t^i(z)}{\partial w_t^i(z)} \frac{w_t^i(z)}{L_t^i(z)}$ be the elasticity of the demand for labor facing the *z* union of insiders. Then, provided that $\eta_t(z) > \lambda(z)$, as we shall ensure below, there exists a unique solution to the problem of the *z* union of insiders, which is interior (i.e., $w_t^i(z) > w_t^o$, $L_t^i(z) > 0$) and such that there is a wage premium given by:

$$\nu_t(z) \equiv \frac{w_t^i(z)}{w_t^o} = \frac{1}{1 - \frac{\lambda(z)}{\eta_t(z)}} \tag{10}$$

This is the well known tangency condition of the union indifference curve and the demand for labor facing that union. In this solution $L_t^i(z)$ is less than the employment level that corresponds to a situation where $w_t^i(z) = w_t^o$.[21] Although all union members are employed, the union restricts

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[21] Observe that, $1/\lambda(z) = -\frac{d[w_t^i(z) - w_t^o]}{dL_t^i(z)} \frac{L_t^i(z)}{w_t^i(z) - w_t^o}$ is the elasticity along the indifference curves of the *z*-union of insiders in the $\left[L_t^i(z),\ w_t^i(z) - w_t^o\right]$ space and $1/\eta_t(z) = -\frac{dw_t^i(z)}{dL_t^i(z)} \frac{L_t^i(z)}{w_t^i(z)}$, is the elasticity of the inverse demand curve for labor faced by the z-union of insiders. Thus, if in the solution to the problem of the *z*-union of insiders the slopes of

employment, and hence union membership, in order to raise the wage rate enjoyed by its members. This, of course, implies an important "misallocation" effect of the insiders-outsiders society. This friction has profound implications for both output and growth. It will be more convenient, however, to examine the important implications of this effect, as well as, the restrictions imposed upon the model's parameters by the condition $\eta_t(z) > \lambda(z),$ after the model's structure has been completed. Again, however, this is consistent with Greek experience, where the workers of publicly provided intermediate goods are organized in powerful and independent labor unions, while the corresponding intermediate good producers are heavily regulated.

2.3 Government Budget

The government's budget constraint, expressed in representative household units, in any given period *t*, is given by:

$$\int_{N_t}^{N_{t+1}} \tilde{\Psi}_t(z)dz + \int_0^{N_t} \hat{\Psi}_t(z)dz = \tau_t \left[r_t k_t + w_t^0 h_t^0 + \int_0^{N_t} w_t^i(z) h_t^i(z) dz \right] \tag{11}$$

where $\tilde{\Psi}_t(z)$ is the cost of setting up (dismantling) new (old) *z* intermediate good infrastructure in period *t* and $\hat{\Psi}_t(z)$ is the cost of administering and maintaining the existing *z* intermediate good infrastructure in period *t*. That is, the first term in the LHS of (11) should be thought of as the investment cost of new infrastructure and the second term in the LHS of (11) as the cost of maintaining the existing infrastructure.[22] $\tilde{\Psi}_t(z)$ and $\hat{\Psi}_t(z)$ will be further specified, shortly.

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these two curves must be the same, we must have: $\dfrac{w_t^i(z)}{w_t^o} = [1/\lambda(z)]/\{[1/\lambda(z)] - [1/\eta_t(z)]\}$. Hence, $\eta_t(z) > \lambda(z)$ implies that $w_t^i(z) > w_t^o$. Now, the last fact and the fact that $\eta_t(z) > 0$, implies that the employment that corresponds to w_t^o , $L_t^{i^c}(z)$, is greater than $L_t^i(z)$.

[22] The introduction of public capital would make equation (11) much less abstract. For example, investment in new publicly provided capital infrastructure could take the form $\int_{N_t}^{N_{t+1}} \tilde{\Psi}_t(\cdot,z) i_t^g(z)dz$, where $\tilde{\Psi}_t(\cdot,z)$ and $i_t^g(z)$ stand for the unit cost and investment quantity of the new *z* intermediate good infrastructure in period *t*, respectively. And, maintenance of existing publicly provided capital infrastructure could take the form $\int_0^{N_t} \hat{\Psi}_t(\cdot,z) k_t^g(z)dz$, where $\hat{\Psi}_t(\cdot,z)$ and $k_t^g(z)$ stand for the unit cost and capital stock of the old *z*-intermediate good infrastructure in period *t*, respectively. Depending on where one wants to focus, $\hat{\Psi}_t(\cdot,z)$ and $\tilde{\Psi}_t(\cdot,z)$ could be specified accordingly. For example, in order to capture adjustment costs in investment quantity, $\tilde{\Psi}_t(\cdot,z)$ could be made to depend on $i_t^g(z)$ and to capture adjustment costs in varieties, $\tilde{\Psi}_t(\cdot,z)$ could be made to depend on z, etc. Likewise, to capture vintage capital, $\hat{\Psi}_t(\cdot,z)$ could be made to depend on $u \in \mathbb{N}_+$, such that $z \in (N_u, N_{u+1})$ for all $u \le t$. And, to capture depreciation, $\hat{\Psi}_t(\cdot,z)$ could be made to depend on $t-u$. We have avoided these complications here, to focus on the essence of the insiders–outsiders society.

2.4 Symmetric Equilibrium

For tractability purposes, in what follows we shall characterize the equilibrium in the symmetric case, where there are no differences across intermediate good service producers, the corresponding insiders' unions, and the distributions of $\Phi(z)$, $\hat{\Psi}_t(z)$ and $\hat{\Psi}_t(z)$ are uniform.

More specifically, we assume: $\Phi(z)=\Phi$; $\Phi>0$, $\lambda(z)=\lambda$; $\lambda\in(0,1)$, $\tilde{\Psi}_t(z)=\tilde{\psi}y_t$; $\hat{\Psi}_t(z)=\hat{\psi}y_t$; $\tilde{\psi}>\hat{\psi}>0$; $\forall z\in[0,N_t]$ & $t\in\mathbb{N}_+$. The last two restrictions make investment in new infrastructure and maintenance of existing infrastructure, fixed functions of output per efficient household. Obviously, these are strong restrictions for analyzing business cycle effects. But, herebelow, they are not so restrictive, as we limit our attention in steady states and convergence towards these steady states. Also, the restriction $\tilde{\psi}>\hat{\psi}$ incorporates the notion that it is more expensive to develop than to maintain one unit of public sector infrastructure.

Then, the equilibrium of this economy, where all agents solve their respective problems and all markets clear, is characterized by the following set of equations:[23]

$$h_t^o=\frac{b\,v(N_t)}{b\,v(N_t)+(1-a-b)}\bar{h} \tag{12}$$

$$N_t\,h_t^i=\frac{(1-\alpha-b)}{bv(N_t)+(1-\alpha-b)}\bar{h} \tag{13}$$

$$y_t=\xi(N_t)k_t^a \tag{14}$$

$$\frac{c_{t+1}}{c_t}=\left[\beta\left(1+g_A\right)^{-1}\left\{\left(1-\delta\right)+\alpha\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\xi(N_{t+1})k_{t+1}^{a-1}\right\}\right]^{\frac{1}{\gamma}} \tag{15}$$

$$\frac{k_{t+1}}{k_t}=\left(1+g_A\right)^{-1}\left\{\left(1-\delta\right)+\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]\xi(N_t)k_t^{a-1}-c_tk_t^{-1}\right\} \tag{16}$$

where

$$v(N_t)\equiv\frac{w_t^i}{w_t^0}=\frac{N_t}{[1-\lambda(1-\zeta)]N_t+\lambda(1-\alpha-b-\zeta)} \tag{17}$$

and

$$\xi(N_t)\equiv b^b(1-a-b)^{(1-a-b)}\Phi^{(1-a-b)}\;N_t^{\frac{(1-a-b)(1-\zeta)}{\zeta}}\;\frac{v(N_t)^b}{[1-a-b+bv(N_t)]^{1-a}} \tag{18}$$

Equations (12) and (13) give the allocation of total household time between final good and intermediate public good production and for that matter between insiders and outsiders, respectively. Equation (14) gives output in the neoclassical growth model format, so that $\xi(N_t)$,

[23] To simplify notation c_t, k_t, y_t in (14)-(16) and henceforth, are equal to the previously defined c_t, k_t, y_t divided by $A_t\bar{h}$.

defined in Equation (18), is total factor productivity, in period *t*. Equations (15) and (16) are the laws of motion of consumption and capital. The former incorporates the government's budget constraint and the latter incorporates the resource constraint of the economy. Equation (17) specifies the public sector wage premium, $\nu(N_t)$, which is tantamount to the wage premium of insiders over outsiders. Clearly, the wage premium affects the economy's resource allocation through total factor productivity. The number of publicly provided intermediate goods, N_t, affects total factor productivity both directly and indirectly through the wage premium. The former is associated to the variety effect and the latter to the misallocation effect, discussed in the Introduction. Hence, the number of publicly provided intermediate goods affects the economy's resource allocation, via after-tax total factor productivity, $\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]\xi(N_t)$, threefold: First, through the wage premium, second through the variety effect, and third through taxation. The latter is associated with what we shall refer to as the "political effect."

2.4.1 The Insiders' Wage Premium

To ensure that the wage premium of insiders over outsiders is greater than one, we need the following parameter restriction:

Assumption 2: $$(1-\zeta)-\frac{1-\alpha-b-\zeta}{N_t}>0$$

This simply implies that the demand for insiders' labor is downward slopping and puts a lower bound on N_t. That is, $N_t \geq \frac{1-\alpha-b-\zeta}{1-\zeta}$. Also, given λ $>\in(0,1)$, Assumptions 1 and 2 ensure that $0<\lambda/\eta=\lambda\left[(1-\zeta)-\frac{1-\alpha-b-\zeta}{N_t}\right]<1$, and it follows from (17) that the wage premium is greater than one. Moreover, in view of Assumption 1: $\nu'(N_t)=\frac{\lambda(1-a-b-\zeta)\left[\nu(N_t)\right]^2}{N_t^2}>0$ and $\nu''(N_t)=\frac{-2\lambda(1-a-b-\zeta)\left[1-\lambda(1-\zeta)\right]\left[\nu(N_t)\right]^3}{N_t^3}<0$. Observe, then, that a necessary and sufficient condition for $\nu'(N_t)$ to be positive (negative) is that intermediate goods are gross complements (substitutes). Hence, Assumption 1 (gross complementarity) ensures that the wage premium increases with the number of intermediate goods. Summarizing results, we have shown the following:

***Proposition 1* (Properties of Insiders' Wage Premium):** *Given Assumptions 1 and 2,* $v(N_t):\left(\frac{1-\alpha-b-\zeta}{1-\zeta},+\infty\right)\rightarrow\left(1,\frac{1}{1-\lambda(1-\zeta)}\right)$ *is strictly increasing and strictly concave in* N_t *and approaches asymptotically* $\frac{1}{1-\lambda(1-\zeta)}$. *Also,* $v(N_t)$ *is greater: (i) the greater the relative bargaining power of unions, λ; (ii) the lower the elasticity of labor demand facing intermediate good service producers,* $\eta=\left[1-\zeta-\frac{1-\alpha-b-\zeta}{N_t}\right]^{-1}$*; and (iii) the greater the degree intermediate goods are gross complements,* $1-\alpha-b-\zeta$.

The economic rationale behind the results of Proposition 1 is straightforward. The wage premium is a consequence of the organization of the labor market. And, in particular, of the market power enjoyed by insiders' unions. Suppose, that labor input in the production of services of intermediate goods is supplied competitively. Then, since labor services are identical, equilibrium in the labor market implies that h_t^o and $N_t h_t^i$ are set so that the marginal products of labor in the final good sector and the services of the intermediate goods sector are equal to the common (real) wage rate. And, there is no wage premium (i.e., $v(N_t)=1$). Alternatively, the latter will hold in this model, under two possibilities. First, when $\lambda=0$, that is when the union does not care about the wage premium. And second, when $\eta=+\infty$, that is when the union faces an horizontal demand for labor.

In view of (12) and (13), an immediate implication of Proposition 1 is the following:

Corollary 1: *Given Assumptions 1 and 2, the ratio of employment in the publicly provided intermediate goods sector (i.e., public employment,* $N_t h_t^i$*) over total employment, and employment in the final good sector (i.e., private employment,* h_t^o *)over total employment decrease and increase, respectively, with the public sector wage premium and reach their maximum and minimum values, respectively when there is no wage premium.*

When $v(N_t)>1$, the monopolistic unions restrict labor input, so as to receive a higher wage rate. This result relates to what we refer to as the "labor misallocation" effect**,** to whose implications we turn next.[24]

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[24] Much like the standard insiders-outsiders labor market theory suggests, this model can easily account for outsiders' unemployment, by introducing a minimum wage rate which is greater than w_t^0 and increases the reservation wage of

2.4.2 Total Factor Productivity

Given Proposition 1, total factor productivity, $\xi(N_t)$, is positive. As already mentioned, N_t affects $\xi(N_t)$ both directly, through the middle term in the RHS of (18) and, indirectly, through the relative wage premium, $v(N_t)$. The direct effect of N_t on $\xi(N_t)$ is positive and relates to the production technology assumed. And, in particular, the property of the production function that, as long as intermediate goods are not perfect substitutes (i.e., $0<\zeta<1$), an increase in the number of intermediate goods, increases TFP and output. For, each intermediate good input is subject to diminishing returns to scale and, therefore, for any given amount of the aggregate input, $N_t x_t$, more output is produced if there are more intermediate goods, N_t, composing this aggregate input. This is what is referred to as the "love-for-variety" effect or simply "variety" effect in the growth literature. The indirect effect relates to the wage premium being greater one, for if the wage premium is one, the last term in the RHS of (18) becomes unity. This effect is negative. To check this, we look at the change in $\xi(N_t)$ brought about by a change in the relative wage premium that does not emanate from a change in N_t (i.e., $\left.\frac{\partial\xi}{\partial v}\right|_{N_t\ fixed}$) and the change in $\xi(N_t)$ brought about by a change in N_t (i.e., $\xi'(N_t)$). It follows from (18) that $\left.\frac{\partial\xi}{\partial v}\right|_{N_t\ fixed} \overset{>}{\underset{<}{=}} 0$ as $1+\frac{b}{1-a}(v-1) \overset{>}{\underset{<}{=}} v$. Given Assumptions 1 and 2, $v>1$. But, for $v>1$, $1+\frac{b}{1-a}(v-1)<v$. Therefore, given Assumptions 1 and 2, $\left.\frac{\partial\xi}{\partial v}\right|_{N_t\ fixed}<0$. The latter defines the "labor misallocation effect." Hence, the overall effect on $\xi(N_t)$ of a change in N_t is not obvious. Herebelow, we summarize results and we show that the overall effect on $\xi(N_t)$ of a change in N_t is pos*itive.*

***<u>Proposition 2</u>* (Properties of Total Factor Productivity):** *Given Assumptions 1 and 2,* $\xi(N_t):\left(\frac{1-a-b-\zeta}{1-\zeta},\infty\right)\to\left(\frac{b^b(1-a-b)^{(1-a-b)}\Phi^{(1-a-b)}}{(1-a)^{(1-a)}}\left[\frac{1-a-b-\zeta}{1-\zeta}\right]^{\frac{(1-a-b)(1-\zeta)}{\zeta}},\infty\right)$, *such that: (a)* $\left.\frac{\partial\xi}{\partial v}\right|_{N_t\ fixed}<0$, *and (b)* $\xi'(N_t)>0$, $\forall N_t\in(0,\infty)$.

<u>Proof</u>: In the Appendix.

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insiders. In fact, the higher the wage premium in the public sector, the stronger the "misallocation" effect and the lower the demand for outsiders labor, implying greater unemployment amongst outsiders, for any given minimum wage rate.

That is, given gross complementarity (i.e., Assumption 1) and unions facing downward sloping labor demand (i.e., Assumption 2), the "variety" effect dominates over the "labor misallocation" effect. To further illustrate the implications of this "labor misallocation" effect, associated with the equilibrium considered in the previous subsections, it is instructive to consider the Second Best associated with this equilibrium. In this model, there are two reasons that the equilibrium is not Pareto Optimum: Proportional income taxes and the market power of insiders' unions. Thus, we shall focus our attention to characterizing efficiency losses with respect to a "Second Best" outcome. That is, when there is no insiders-outsiders organization of society, but there is a "tax distortion" effect. In this case, of course, there are no insiders' unions and there is no relative wage premium, nor a "labor misallocation" effect. Formally, we define as a "Second Best" outcome for this economy an equilibrium, where the relative wage premium $v^{SB}(N_t)=1$, for all $t \in \mathbb{N}_+$. The Second Best is also characterized by (12) – (17), with TFP given by:

$\xi^{SB}(N_t) \equiv \dfrac{b^b(1-a-b)^{(1-a-b)}\Phi^{(1-a-b)}}{(1-a)^{(1-a)}} N_t^{\frac{(1-a-b-\zeta)(1-\zeta)}{\zeta}}$. Consider now the TFP difference function:

$$\pi(N_t) \equiv \xi^{SB}(N_t) - \xi(N_t) = \frac{b^b(1-a-b)^{(1-a-b)}\Phi^{(1-a-b)}}{(1-a)^{(1-a)}} N_t^{\frac{(1-a-b-\zeta)(1-\zeta)}{\zeta}} \left(1 - \frac{(1-a)^{(1-a)} v(N_t)^b}{\left[1-a-b+bv(N_t)\right]^{1-a}}\right).$$

We may think of $\pi(N_t)$ as the TFP gap due to the "labor misallocation" effect. Clearly, this TFP gap is proportional to the corresponding output gap, $y_t^{SB} - y_t = \pi(N_t)k_t^a$. This is a measure of the equilibrium efficiency losses relative to the Second Best, where there is no insiders-outsiders organization of society. First, we characterize the sign of $\pi(N_t)$ and second, the change of $\pi(N_t)$. As in the case of $\xi(N_t)$, it is useful to distinguish between two effects: The change in $\pi(N_t)$ brought about by a change in the relative wage premium that does not emanate from a change in N_t (i.e., $\left.\frac{\partial \pi}{\partial v}\right|_{N_t\ fixed}$) and the change in $\pi(N_t)$ brought about by a change in N_t (i.e., $\pi'(N_t)$). Then it is a straightforward application of the results in Propositions 1 and 2 that:

Corrolary 2 (Second Best): *Given Assumptions 1 and 2,* $\pi(N_t):(0,\infty)\to(0,\infty)$, $\left.\frac{\partial \pi}{\partial v}\right|_{N_t\ fixed} > 0$*, and* $\pi'(N_t) > 0$, $\forall N_t \in (0,\infty)$.

Proof: In the Appendix.

As a consequence of the labor misallocation effect, the TFP gap increases with both the public sector wage premium and the number of publicly provided intermediate goods.

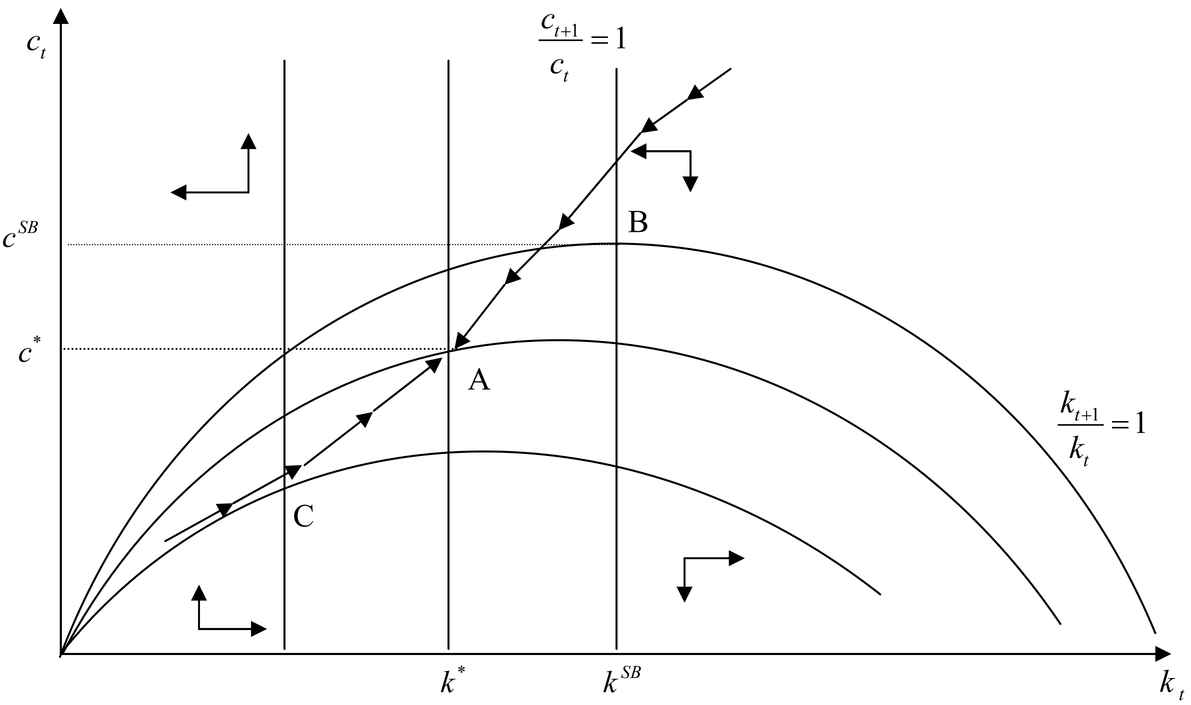
2.4.3 Growth with a Fixed Number of Publicly Provided Intermediate Goods

Next, we turn to the question of how the number of publicly provided intermediate goods affects capital, output and growth. There are two ways to look into the answer to this question: with a fixed and a variable number of publicly provided intermediate goods. It is instructive to start the analysis with a fixed (given) number of publicly provided intermediate goods. In the case where N_t is fixed, say, $N_t = \bar{N}$, such that $\hat{\psi}\bar{N} \in (0,1)$, $\forall t \in N_+$, the transitional dynamics of the equilibrium are now characterized by:

$$\frac{c_{t+1}}{c_t} = \left\{\beta(1+g_A)^{-1}\left[(1-\delta)+\alpha(1-\hat{\psi}\bar{N})\xi(\bar{N})k_{t+1}^{\alpha-1}\right]\right\}^{\frac{1}{\gamma}}$$

$$\frac{k_{t+1}}{k_t} = (1+g_A)^{-1}\left[(1-\delta)+(1-\hat{\psi}\bar{N})\xi(\bar{N})k_t^{\alpha-1} - c_t k_t^{-1}\right]$$

Figure 2: Steady state and transitional dynamics with fixed number of publicly provided intermediate goods, $\bar{N}$



Thus, any equilibrium steady state, say $(k^*, c^*) \in (0,\infty)\times(0,\infty)$ must satisfy the conditions $\frac{k_{t+1}}{k_t} = \frac{c_{t+1}}{c_t} = 1$, $\forall t \in N_+$. It follows from the above two equations that the locus $\frac{c_{t+1}}{c_t} = 1$ is given by the vertical line in Figure 2. And, the locus $\frac{k_{t+1}}{k_t} = 1$ is given by the inverse U-shaped curve in Figure 2. The intersection of these two lines (point A) defines the equilibrium steady state

$\left(k^*,c^*\right)=\left(\left[\dfrac{\alpha(1-\hat{\psi}\bar{N})\xi(\bar{N})}{\beta^{-1}(1+g_A)-(1-\delta)}\right]^{\frac{1}{1-\alpha}},(1-\hat{\psi}\bar{N})\xi(\bar{N})k^{*\alpha}-(g_A+\delta)k^*\right)$. Also, it follows by the above two equations that the transitional dynamics around this steady state are as indicated by the directions of the arrows in Figure 2. Following standard arguments, it can be shown that there exists a unique stable local trajectory to the steady state, to which the economy converges, monotonically. Given any initial value of k_0, consumption "jumps" to the value that corresponds to this stable local trajectory. Clearly, $\left(k^*,c^*\right)$ differs from the steady state of the Second Best (point B, say $\left(k^{SB},c^{SB}\right)$), which lies to the north east of point A, by virtue of Corollary 2. And, for any given initial value of k_0, transitional dynamics (monotone convergence) will imply higher growth rates towards the steady state of the Second Best, versus that of point A.

Now, we are interested in the steady state and the transitional dynamics for different values of $\bar{N}$. Consider first an increase in the relative wage premium $\nu(.)$ that does not come from a change in $\bar{N}$. Clearly, in this case, following Proposition 2, $\xi(\bar{N})$ will decrease. The $\dfrac{k_{t+1}}{k_t}=1$ locus will drop and the $\dfrac{c_{t+1}}{c_t}=1$ locus will move left. The new steady state (illustrated by point C, in Figure 2) will lie to the south west of $\left(k^*,c^*\right)$. And, convergence to this steady state will imply slower growth. Finally, if $\bar{N}$ increases, both loci will move in the direction $(1-\hat{\psi}\bar{N})\xi(\bar{N})$ moves. Where the new steady state is going to be, is now ambiguous and depends on the way $(1-\hat{\psi}\bar{N})\xi(\bar{N})$ changes with $\bar{N}$. As the following proposition makes clear, for $\bar{N}$ sufficiently high, $(1-\hat{\psi}\bar{N})\xi(\bar{N})$ will decrease with $\bar{N}$. But, for $\bar{N}$ sufficiently low the opposite might be true.

***<u>Proposition 3</u>* (Variety and Labor Misallocation Effects vs Tax Distortion Effect):** *Given Assumptions 1 and 2,* $\dfrac{d(1-\hat{\psi}\bar{N})\xi(\bar{N})}{d\bar{N}}<0$ *for all* $\bar{N}\in\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\dfrac{1}{\hat{\psi}}\right)$*, such that:* $\bar{N}>\dfrac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}$*. And if,* $\dfrac{1-\alpha-b-\zeta}{1-\zeta}<\dfrac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}$*, there exists a sub-interval* $\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\bar{N}'\right)$ *of* $\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\dfrac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}\right)$ *such that* $\dfrac{d(1-\hat{\psi}\bar{N})\xi(\bar{N})}{d\bar{N}}>0$*, for all* $\bar{N}$ *in this sub-interval.*

<u>Proof</u>: In the Appendix.

Since, $\hat{\psi}$ should be a relatively small number, the condition $\frac{1-\alpha-b-\zeta}{1-\zeta} < \frac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}$, puts an upper bound on $\hat{\psi}$, that seems reasonable for all practical purposes. For that matter, we shall refer to $\frac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}$ as the threshold value of *N*.

Proposition 3 can be illustrated in Figure 2, also. In this case, an increase in $\overline{N}$ that decreases (increases) $(1-\hat{\psi}\overline{N})\xi(\overline{N})$ corresponds to a movement northeast (southwest) of point A, like point C (B). Hence, in the case of a fixed number of publicly provided intermediate goods, an increase in the number of these goods will have ambiguous effects on steady state output and growth towards this steady state, as these effects will depend on the existing number of publicly provided intermediate goods. However, the rationale for this nonlinearity is straightforward. For a relatively low *N*, an increase in this number is associated with the dominance of the “variety” effect over the combination of the “labor misallocation” and “tax distortion” effects. On the contrary, for a relatively high *N*, an increase in this number is associated with the dominance of the combination of the “labor misallocation” and “tax distortion” effects over the “variety” effect. For, as it can be easily verified, the “variety” effect (“labor misallocation” and “tax distortion” effects) is decreasing (are increasing) with *N*. The important implication of this result for the stylized facts of the Introduction, will be discussed in the next section.

2.5 Government’s Objective Function

The stage has, now, been set to investigate the case of an endogenous income tax rate or an endogenous number of publicly provided intermediate goods, N_t. This income tax rate or number of publicly provided intermediate goods, of course, must be decided by government. To do this, we must specify the government’s objective function. Once the government objective function is specified, the problem of government is a straightforward social planner’s problem. That is, government decides on the income tax rate or the number of publicly provided intermediate goods, so as to maximize its objective function, subject to the equilibrium laws of motion of the previous section and the government budget constraint. The solution to this problem is the so called politicoeconomic equilibrium.

First, we consider the case of the Median Voter Government, where the objective function of government is the objective function of the representative household. Moreover in order to simplify, henceforth, we consider the case where $\gamma=\delta=1$. This is the case of logarithmic household preferences and full capital depreciation. Then, the equilibrium laws of motion (15) and (16), reduce to:[25]

$$c_t = (1-a\beta)\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]\xi(N_t)k_t^a \tag{19}$$

$$k_{t+1} = a\beta\left(1+g_A\right)^{-1}\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]\xi(N_t)k_t^a \tag{20}$$

And, the temporal utility function of the representative household becomes logarithmic, so that the objective function of the representative household and the so called Median Voter Government is given by:

$$\begin{aligned} W^{MV}\left[\left\{k_{t+1},N_{t+1}\right\}_{t=0}^{\infty};\left(k_0,N_0\right)\right] &= \sum_{t=0}^{\infty}\beta^t \ln c_t \\ &= \sum_{t=0}^{\infty}\beta^t \ln\left\{(1-a\beta)\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]\xi(N_t)k_t^a\right\} \end{aligned} \tag{21}$$

The problem of the Median Voter Government is to find a plan of the form $\left\{k_{t+1},N_{t+1}\right\}_{t=0}^{\infty}$ so as to maximize (21), subject to (20). We shall refer to the solution of this problem as the Median Voter politicoeconomic equilibrium. It should be mentioned that the government budget constraint, is such that choosing the number of intermediate goods in the beginning of period *t+1* completely determines the income tax rate. Thus, this politicoeconomic equilibrium assumes that there is a commitment technology with respect to the income tax rate.[26]

Second, motivated by the Greek paradigm, where political parties and governments have been dominated by unions and especially those of the greater public sector, we wish to consider a situation where insiders' unions are controlling government.[27] We shall refer to this type of government as Government of Insiders. But since in the equilibrium considered in the previous subsection and, in particular, in the Nash equilibrium characterizing the outcome of the insiders' unions strategic interaction, we assumed that each union takes the number of publicly provided intermediate goods as given and beyond their control, it seems contradictory to argue that unions cooperate to control/influence government.[28] However, there is no such contradiction. Unions "play" non-cooperatively vis-à-vis each other with respect to the wage rate, as an increase in the wage rate set by each union affects positively its own utility but negatively each other union. This is because, such an increase, due to the assumed gross complementarity, lowers labor demand facing all other unions. But, have an incentive to cooperate with each other with respect to the income tax

[25] To verify this, observe that (20) comes as an implication of the resource constraint (16) and that (19) satisfies the Euler condition (15).

[26] Admittedly, here we avoid all problems that arise due to the lack of such commitment. See, e.g., Acemoglu (2009, Ch. 22), for what is referred to as the "hold up" problem.

[27] Pertinent references are given in Kollintzas, et al. (2012).

[28] This is what is referred to as "political elite" (see e.g., Acemoglu 2009, ch. 22). Elites are taken to make the political decisions and possibly engage in economic activities. In our case, the political elite consists of the members of insiders' unions. Or, again, in Acemoglu's terminology, we assume insiders' unions to enjoy de facto political power.

rate / the number of publicly provided intermediate goods. This is because a higher, say, income tax rate, increases the number of publicly provided intermediate goods and increases the demand for labor facing each union, also due to gross complementarity. Hence, all insiders' unions have an incentive to increase this tax rate (financing of the underlying infrastructure). For that matter, unions' interests are simultaneously to compete for wage premiums and cooperate for the number of publicly provided intermediate goods. On the contrary, however, in a world of no insiders, there is no need for such cooperation. We consider then the objective function of Insiders Government to be a function of the sum of utilities of all insiders' unions, $\sum_{t=0}^{\infty}\beta^t \ln \int_0^{N_t}\left[w_t^i(z)-w_t^0\right]^{\lambda(z)} L_t^i(z)dz$, which in the symmetric case reduces to:

$$\begin{aligned} W^{GI}\left[\{k_{t+1},N_{t+1}\}_{t=0}^{\infty};(k_0,N_0)\right] &= \sum_{t=0}^{\infty}\beta^t \ln\left[\upsilon(N_t)\xi(N_t)k_t^a\right]^{\lambda} \\ &= \sum_{t=0}^{\infty}\beta^t\left\{\lambda \ln\left[\frac{\upsilon(N_t)}{(1-a\beta)\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]}+\lambda \ln c_t\right]\right\} \end{aligned} \tag{22}$$

where

$$\upsilon(N_t)=\frac{\left[\nu(N_t)-1\right]}{\nu(N_t)\left[1-a-b+b\nu(N_t)\right]^{(1-\lambda)/\lambda}} \tag{23}$$

The problem of the Government of Insiders is to find a plan of the form $\{k_{t+1},N_{t+1}\}_{t=0}^{\infty}$ so as to maximize (22), subject to (20). Clearly, then, Median Voter Government preferences depend on consumption of the representative household only. But, Government of Insiders preferences depend on a fraction, λ, of the representative household preferences; the function $\upsilon[\nu(N_t)]$, which, as will be shown in the proof of the next proposition, is an increasing and concave of the public sector wage premium, $\nu(N_t)$; and government's share of output, $\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]$. Interestingly, as can be seen from (23), this last dependence occurs in such a way so as to offset the effect of the government's share of output incorporated in the consumption of the representative household.

Further, since we are interested in comparing societies with different politicoeconomic structures, we wish to consider a hybrid of the government objective functions introduced above. That is, following the political economy literature (see, e.g., Persson and Tabellini (2002), Ch. 7), we consider a government that to some degree is influenced by representative household preferences and is influenced, likewise, by insiders' unions preferences. Thus, to avoid scale problems, we consider a government that seeks to minimize a weighted average of the percentage deviations of: (a) the welfare of the representative household from the welfare achieved under the solution of the Median Voter; and (b) the welfare of all insiders' unions from the welfare achieved under the solution of the Government of Insiders:[29]

$$W^{\rho}=\frac{\rho\left\{\overline{W}^{MV}-W^{MV}\left[\left\{k_{t+1},N_{t+1}\right\}_{t=0}^{\infty};\left(k_0,N_0\right)\right]\right\}}{\overline{W}^{MV}}+\frac{(1-\rho)\left\{\overline{W}^{GI}-W^{GI}\left[\left\{k_{t+1},N_{t+1}\right\}_{t=0}^{\infty};\left(k_0,N_0\right)\right]\right\}}{\overline{W}^{GI}} \tag{24}$$

subject to the capital law of motion (20), where $1-\rho\in\left(0,1\right)$ is the relative influence of insiders' unions on government. We shall refer to this problem as the problem of the Hybrid Government and to the solution of this problem as the Hybrid politicoeconomic equilibrium. Clearly, for $\rho=1$ ($\rho=0$), the Hybrid politicoeconomic equilibrium collapses to the Median Voter (Government of Insiders) one. And, for an appropriate choice of $\rho\in(0,1)$, the Hybrid equilibrium represents a politicoeconomic equilibrium with any given degree of insiders influence over the representative household in government decisions.

3. POLITICOECONOMIC EQUILIBRIUM

In this section we characterize the basic properties of the Hybrid politicoeconomic equilibrium. The following is the main result of this paper.

Proposition 4 (Politicoeconomic equilibrium): *Suppose* $\rho\in[0,1)$ or $\rho=1$ *and*

Assumption 3 $\qquad \dfrac{(1-a-b)(1-\zeta)\left[1-\varsigma-\hat{\psi}(1-a-b-\zeta)\right]}{(1-a-b-\zeta)\zeta}>\left(\beta^{-1}-1\right)\tilde{\psi}+\hat{\psi}$,

Then, given Assumptions 1 and 2:

(a) The Hybrid politicoeconomic equilibrium is characterized by (20) and

$$\varphi(N_{t+1})=\frac{\beta^{-1}\tilde{\psi}}{1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t}-\frac{\tilde{\psi}-\hat{\psi}}{1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}}; \tag{25}$$

where

$$\varphi(N_{t+1})=A\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}+B\frac{\upsilon'(N_{t+1})}{\upsilon(N_{t+1})}; \tag{26}$$

with $(A,B)=\left(\dfrac{\rho+\lambda(1-\rho)}{\rho+\alpha\beta\lambda(1-\rho)},\dfrac{(1-\alpha\beta)\lambda(1-\rho)}{\rho+\alpha\beta\lambda(1-\rho)}\right)$.

(b) There exists a unique steady state, $\left(k^{\rho},N^{\rho}\right)\in(0,\infty)x\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\dfrac{1}{\hat{\psi}}\right)$, *associated with this equilibrium, such that:*

[29] We prove below that the solutions to the Median Voter government and the Government of Insiders exist, so that (24) is well defined.

$$k^{\rho} = \left[\frac{a\beta(1-\hat{\psi}N^{\rho})\xi(N^{\rho})}{1+g_A} \right]^{\frac{1}{1-a}} \tag{27}$$

and N^{ρ} *is the unique solution to:*

$$(1-\hat{\psi}N)\varphi(N) = (\beta^{-1}-1)\tilde{\psi} + \hat{\psi} \,. \tag{28}$$

(c) Moreover, an increase in the relative influence of insiders' unions, $1-\rho$*, would lead to a higher steady state value,* N^{ρ}*.*

Proof: In the Appendix.

Difference equations (20) and (25) describe the transitional dynamics of the politicoeconomic equilibrium. Condition (25) is the key condition characterizing the transition of publicly provided intermediate goods. These costs (benefits) are measured in terms of discounted utility decreases (increases) associated with decreases (increases) of an equivalent amount in consumption, as the amount of resources used to increase (decrease) the number of publicly provided intermediate goods. It is instructive to consider, first, these costs and benefits in the simpler case of the Median Voter politicoeconomic equilibrium. In this case, $\rho = 1$, so that $A = 1$ and $B = 0$; and therefore, $\varphi(N_{t+1}) = \dfrac{\xi'(N_{t+1})}{\xi(N_{t+1})}$. Then, observe that an increase in the number of publicly provided intermediate goods in any given period *t* on private capital will involve the following four effects: (i) A decrease at the beginning of period $t+1$ at a rate equal to $a\beta\tilde{\psi}[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t]\xi(N_t)k_t^a$, due to the diversion of resources from private capital to the construction of the underlying infrastructure associated with the increase in the number of publicly provided intermediate goods (i.e., new infrastructure). (ii) A decrease at the beginning of period $t+2$ at a rate equal to $a\beta\hat{\psi}[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}]\xi(N_{t+1})k_{t+1}^a$, due to the diversion of resources from private capital to the maintenance of the new public sector infrastructure. (iii) An increase at the beginning of period $t+1$ at a rate equal to $a\beta\tilde{\psi}[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}]\xi(N_{t+1})k_{t+1}^a$, due to the ensuing non-diversion of resources to the construction of this infrastructure, since it is already in place. (iv) An increase at the beginning of period $t+1$ at a rate equal to $a\beta[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}]\dfrac{\xi'(N_{t+1})}{\xi(N_{t+1})}\xi(N_{t+1})k_{t+1}^a$, due to the increase in TFP, brought about by the new infrastructure. In terms of discounted utility, changes in consumption in period *t* are valued at $\beta^t c_t^{-1} = \beta^t\{(1-a\beta)[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t]\xi(N_t)k_t^a\}^{-1}$ and, changes in consumption in period $t+1$ are valued at $\beta^{t+1}c_{t+1}^{-1}$. Hence, in terms of discounted utility, the costs and benefits associated with a marginal increase in the number of publicly provided intermediate goods are

$$\beta^t c_t^{-1} a\beta\tilde{\psi}[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t]\xi(N_t)k_t^a + \beta^{t+1}c_{t+1}^{-1}a\beta\hat{\psi}[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}]\xi(N_{t+1})k_{t+1}^a$$

and

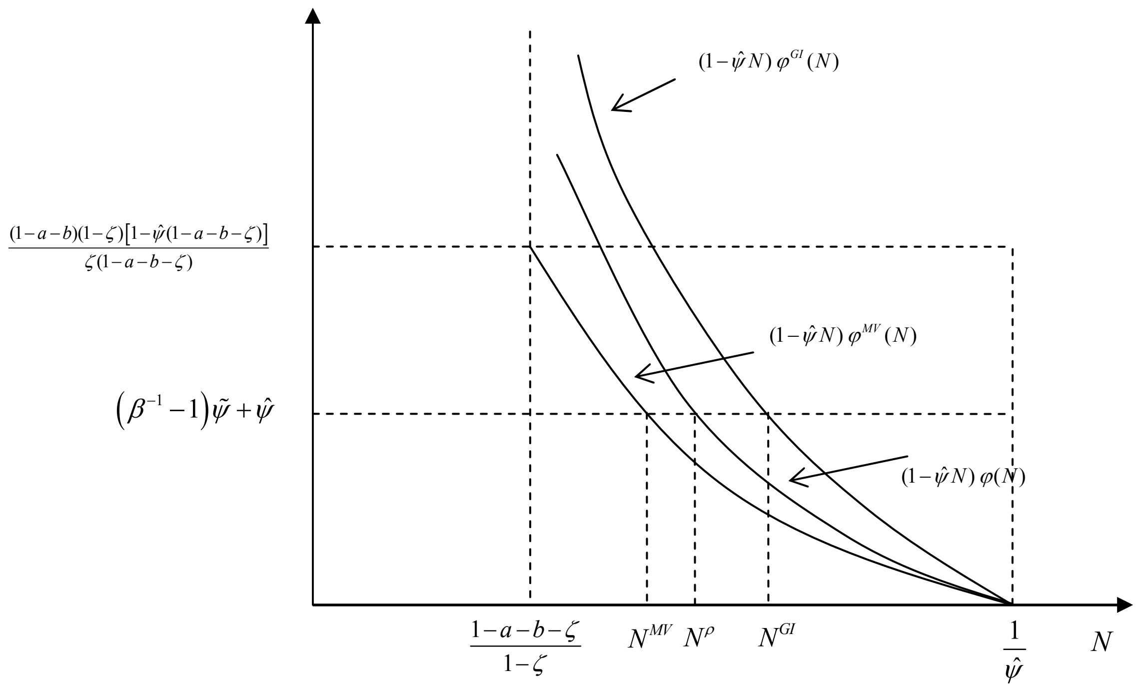
$$\beta^{t+1}c_{t+1}^{-1}\{a\beta\tilde{\psi}[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}]\xi(N_{t+1})k_{t+1}^a + a\beta[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}]\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\xi(N_{t+1})k_{t+1}^a\}$$

respectively. Simplifying terms, it follows that (25), simply requires that these costs and benefits should be equal at the margin. In the opposite case of the Government of Insiders politicoeconomic equilibrium, where $\rho = 0$, so that $A = \frac{1}{a\beta}$ $B = \frac{1-a\beta}{a\beta}$, $\varphi(N_{t+1}) = \frac{1}{a\beta}\left[\frac{\xi'(N_{t+1})}{\xi(N_{t+1})} + (1-a\beta)\frac{\upsilon'(N_{t+1})}{\upsilon(N_{t+1})}\right]$. Then, observe that an increase in the number of publicly provided intermediate goods, in this case, will involve exactly the four effects (i) – (iv) on private capital as in the case of the Median Voter politicoeconomic equilibrium, but now these changes are valued differently. That is, in terms of discounted utility, changes in consumption in period t and period $t+1$ are, now, valued at $\lambda\beta^t c_t^{-1}$ and $\lambda\beta^{t+1}c_{t+1}^{-1}$, respectively. Moreover, discounted utility is, now, directly (i.e., not through consumption) affected by four additional terms. First, in period $t+1$, by $\lambda\beta^{t+1}\frac{\upsilon'(N_{t+1})}{\upsilon(N_{t+1})}$, as the increase in the number of publicly provided intermediate goods raises the public sector wage premium, increasing the utility of insiders. Finally, the other three terms are opposite and proportional (i.e., multiplied by $-(1-a\beta)$) as the effects (i)-(iii) on private capital. This, as already mentioned, is due to the fact that insiders preferences depend directly, positively, on governments, share of output (i.e., through $\{(1-a\beta)[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t]\}^{-1}$). Again, equating these costs and benefits gives (25), for $\rho = 0$. Clearly then, for $\rho \in (0,1)$, (25) is a linear combination of its above two special versions. Interestingly, the weights in this linear combination (i.e., *A* and *B*) depend not only on ρ, but on insiders union power, *λ,* and the technological parameters *a* and *b.*

Now, the stage has been set to look into the steady state of the politicoeconomic equilibrium. This steady state is characterized by (27) and (28). Condition (28), that characterizes the steady state number of publicly provided intermediate goods, is crucial. First, recall that Proposition 2 ensures that $\frac{\xi'(N)}{\xi(N)}$ is strictly positive. Likewise, it is shown that, given Assumptions 1 and 2, $\frac{\upsilon'(N)}{\upsilon(N)}$ is strictly positive. Moreover, it is shown that $\frac{\upsilon'(N)}{\upsilon(N)}$ approaches $+\infty$, as *N* approaches $\frac{1-a-b-\zeta}{1-\zeta}$ *(i.e.,* $v(N)$ approaches 1) and approaches 0, as *N* approaches $\frac{1}{\hat{\psi}}$ (i.e., the endpoint of its range). Further, it is shown that both $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ and $(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}$ are strictly decreasing and strictly concave in *N*. Clearly then, $(1-\hat{\psi}N)\varphi(N)$ is positive, strictly decreasing, strictly concave and approaches 0, as N approaches $\frac{1}{\hat{\psi}}$. Further, when $\rho \in [0,1)$, it approaches $+\infty$, as N approaches $\frac{1-a-b-\zeta}{1-\zeta}$. These facts, imply that when $\rho \in [0,1)$, (28) has a unique interior solution, N^{ρ}. This fact is illustrated in Figure 3, below, where the $(1-\hat{\psi}N)\varphi(N)$ locus intersects the $(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}$ locus at a unique point $N^{\rho} \in \left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}}\right)$.

When $\rho = 1$ (i.e, in the Median Voter politicoeconomic equilibrium), $A=1$ and $B=0$. Then, $(1-\hat{\psi}N)\varphi(N) = (1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$ and Assumption 3 in needed to ensure that the $(1-\hat{\psi}N)\varphi(N)$ locus takes a value higher than $(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}$, as N approaches $\frac{1-a-b-\zeta}{1-\zeta}$.

Figure 3. Illustration of existence and uniqueness of the steady state politicoeconomic equilibria.



In Figure 3, $(1-\hat{\psi}N)\varphi(N)$ for the Median Voter and Government of Insiders politicoeconomic equilibria are denoted by $(1-\hat{\psi}N)\varphi^{MV}(N)$ and $(1-\hat{\psi}N)\varphi^{GI}(N)$, respectively. Obviously, since $(1-\hat{\psi}N)\varphi^{MV}(N) < (1-\hat{\psi}N)\varphi^{GI}(N)$, the steady state number of publicly provided intermediate goods in the Median Voter politicoeconomic equilibrium, N^{MV}, is less than the corresponding number of the Government of Insiders politicoeconomic equilibrium, N^{MV}. The ordering between

N^{GI} and N^{MV} is a manifestation of the "political effect" mentioned in the Introduction. Recall that the Median Voter solution incorporates the "labor misallocation" effect. So, steady state capital per efficient household in the Median Voter solution is already lower than the Second Best (i.e., the no wage premium but with distorting taxation Median Voter politicoeconomic equilibrium).[30] Thus, while the Median Voter social planner chooses the number of publicly provided intermediate goods balancing (at the margin) the "variety" effect with the combination of the "labor misallocation" and the "tax distortion" effects, the Government of Insiders chooses that number so as to balance the same effects but with greater values for these effects, due to the utility gains from the public sector wage premium and government's share of output. For that matter, the Government of Insiders chooses a greater number of intermediate goods than the Median Voter social planner. In fact, as Part c of Proposition 4 makes clear, generally, an increase in insiders influence over government, $(1-\rho)$, would imply a higher steady state number of publicly provided intermediate goods.

Next, we turn on steady state capital, given by (27). Combining Propositions 3 and 4, it is apparent that there is no direct answer to the question whether there will be a higher or a lower steady state capital in the Median Voter social planner solution or the Government of Insiders solution. Or, in general in the Hybrid politicoeconomic equilibrium, how steady state capital will vary with an increase in the influence of insiders over government. In particular, for relatively low numbers of steady state publicly provided intermediate goods, N^{ρ}, an increase in insiders influence over government, leading to a higher number of those goods in the steady state, may entail higher steady state capital and faster growth (i.e., growth along the convergence to the steady state). But, for a relatively higher number of steady state publicly provided intermediate goods, N^{ρ}, a higher number for these goods leads to lower steady state output and growth. We summarize this important result in the following corollary.

<u>Corollary 3:</u> *Consider two values of* $(1-\rho)$, $(1-\rho')$ and $(1-\rho'')$, such that $(1-\rho')>(1-\rho'')$. Suppose that $\left(k^{\rho'},N^{\rho'}\right)$ *and* $\left(k^{\rho''},N^{\rho''}\right)$ *are the steady states defined in Proposition 4 that correspond to* $(1-\rho')$ and $(1-\rho'')$, respectively. *If* $N^{\rho'},N^{\rho''}\in\left[\dfrac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]},\dfrac{1}{\hat{\psi}}\right)$, *so that* $\dfrac{d(1-\hat{\psi}N)\xi(N)}{dN}<0,\quad k^{\rho''}>k^{\rho'}$. *And, if* $N^{\rho'},N^{\rho''}\in\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\dfrac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]}\right)$ *so that* $\dfrac{d(1-\hat{\psi}N)\xi(N)}{dN}>0$, *then* $k^{\rho''}<k^{\rho'}$.

---

[30] In terms of Figure 3, the Second best corresponds to a solution with a $(1-\hat{\psi}N)\dfrac{\xi'(N)}{\xi(N)}$ locus that declines faster than the one depicted in this figure.

Unfortunately, no clear cut answer can be obtained if $N^{\rho'}$ is in the sub-interval of relatively large N and $N^{\rho''}$ is in the sub-interval of relatively low N.

Proposition 4 is helpful in explaining the stylized facts of the Introduction. For, if countries differ with respect to $1-\rho$ (i.e., the relative weight of insiders in influencing the government), countries with high $1-\rho$ will eventually have a high number of publicly provided intermediate goods and these countries will be more likely to have a number of publicly provided intermediate goods which is higher than the threshold of Proposition 3. Then these countries will have lower steady state capital and output, than countries with relatively low $1-\rho$.

We conclude this section with establishing that the Hybrid politicoeconomic equilibrium is at least asymptotically stable around the steady state. In particular, it is characterized by a sequence of numbers of publicly provided intermediate goods, $\{N_t\}_{t=0}^{\infty}$, converging monotonically to the steady state, for any N_0, sufficiently close to N.

<u>Proposition 5</u> *(a) Let $\{N_t\}_{t=0}^{\infty}$ be the solution to (25) for any given N_0 and let N be the unique steady state defined by (28). Around this steady state, the first order approximation of the solution to (25), $N_{t+1} = g\ (N_t)$, $N = g(N)$, for some function $g(\cdot): \left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}}\right) \to \left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}}\right)$, is given by:*

$$N_{t+1} = g\ (N_t) \simeq (1-\sigma)N + \sigma N_t\ , \tag{29}$$

where,

$$\sigma = \frac{1}{2}\left[\left[\frac{\beta^{-1}\tilde{\psi}}{\tilde{\psi}-\hat{\psi}} + \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}} - \frac{\left(1-\hat{\psi}N\right)^2}{\tilde{\psi}\left(\tilde{\psi}-\hat{\psi}\right)}\varphi'(N)\right] - \left\{\left[\frac{\beta^{-1}\tilde{\psi}}{\tilde{\psi}-\hat{\psi}} + \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}} - \frac{\left(1-\hat{\psi}N\right)^2}{\tilde{\psi}\left(\tilde{\psi}-\hat{\psi}\right)}\varphi'(N)\right]^2 - 4\beta^{-1}\right\}^{1/2}\right].$$

$$\in \left(0, \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}}\right) \subset (0,1)$$

Proof: In the Appendix.

Since, $\sigma \in \left(0, \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}}\right)$, it follows that the convergence of the number of publicly provided intermediate goods to its steady state, N, is monotonic. Moreover, it follows from (20) and (29) that around the steady state (k, N) of the politicoeconomic equilibrium, the law of motion of capital can be approximated by:

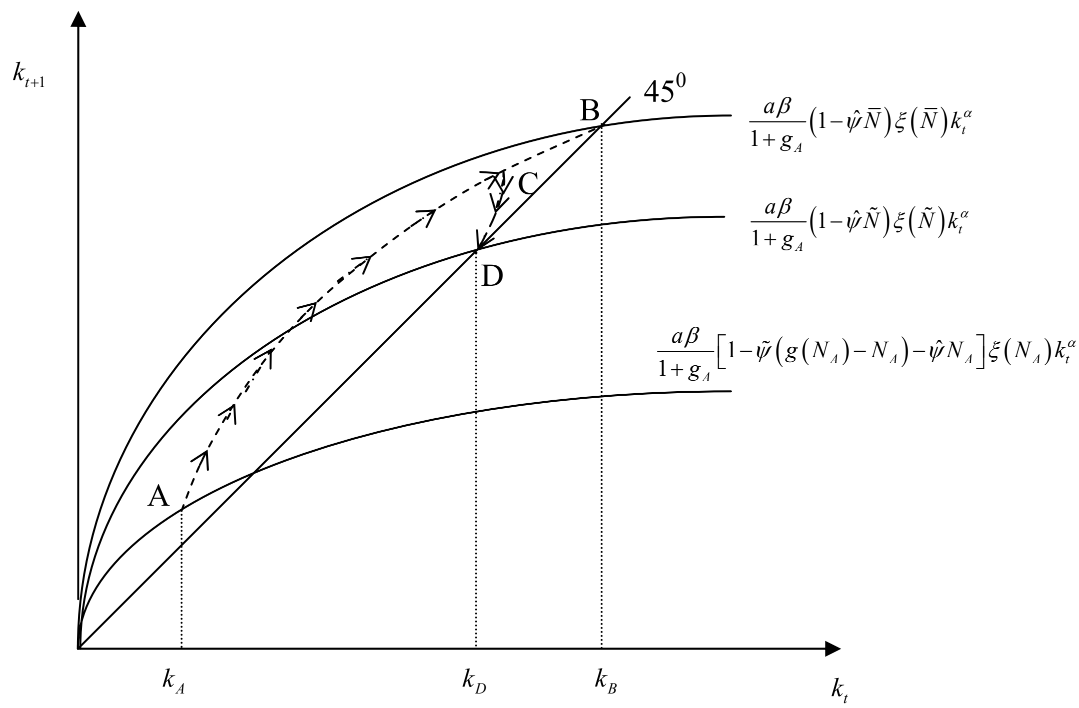
$$k_{t+1} = a\beta\left(1+g_A\right)^{-1}\{1-(1-\sigma)\tilde{\psi}N + [(1-\sigma)\tilde{\psi}-\hat{\psi}]N_t\}\xi(N_t)k_t^{\ a} \tag{30}$$

And, since $\sigma \in \left(0, \frac{\tilde{\psi} - \hat{\psi}}{\tilde{\psi}}\right)$, $(1-\sigma)\tilde{\psi} - \hat{\psi} > 0$ and therefore the convergence of capital is also monotonic.

4. STYLIZED FACTS EXPLANATIONS AND THE CASE OF A GROWTH REVERSAL

Recall from Proposition 4, that an increase in insiders influence over government (i.e., $1-\rho$) will lead to an increase in the steady state number of publicly provided intermediate goods, N. Further, recall from Proposition 3 that steady state TFP, $(1-\hat{\psi}N)\xi(N)$, does not change monotonically with the steady state number of publicly provided intermediate goods, N. That is, for a relatively low N, an increase in this number is associated with the dominance of the "variety" effect over the combination of the "labor misallocation" and the "political effect," while the opposite is true after a certain threshold, $\bar{N}$. These results, along with the monotonic convergence of $\left\{k_t, N_t\right\}_{t=0}^{\infty}$ towards (k, N), established in Proposition 5, allow for the possibility of a growth reversal, brought about by an increase in insiders influence over government. Despite the fact that here we have two state variables, this possibility can be illustrated with the help of the standard neoclassical growth phase diagram.

Figure 4: A Growth Reversal

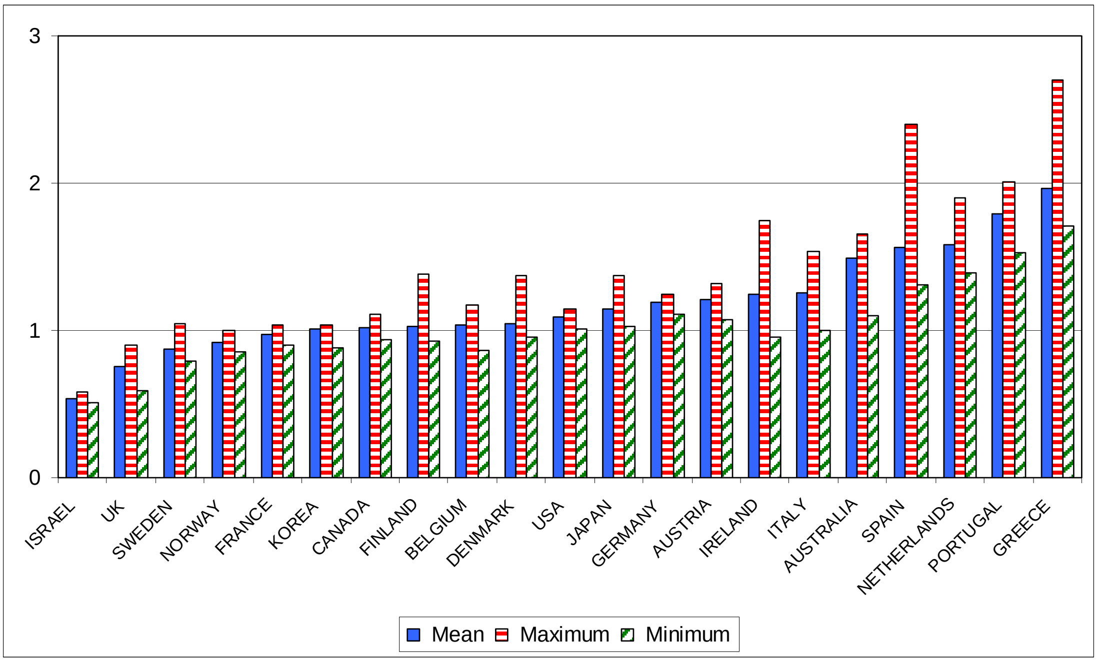


In Figure 4, the horizontal axis measures capital in the current period and the vertical axis measures capital in the next period. For any given (k_t, N_t) in the current period, capital in the next period is given by $\frac{a\beta}{1+g_A}\{1-\tilde{\psi}[g(N_t)-N_t]-\hat{\psi}N_t\}\xi(N_t)k_t^a$, like point A in Figure 4. The steady state of capital is given by the intersection of the 45^0 line and the locus $\frac{a\beta}{1+g_A}(1-\hat{\psi}N)\xi(N)k^a$, where $N = g(N)$. Suppose, now, that $N \le \bar{N}$, where $\bar{N}$ is the threshold value (i.e., $\frac{d(1-\hat{\psi}\bar{N})\xi(\bar{N})}{d\bar{N}} = 0$ and for N below (above) $\bar{N}$, $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} > 0\ (< 0)$). Clearly, the locus $\frac{a\beta}{1+g_A}(1-\hat{\psi}\bar{N})\xi(\bar{N})k^a$, as long as $N_t < \bar{N}$, lies above any transition locus $\frac{a\beta}{1+g_A}\{1-\tilde{\psi}[g(N_t)-N_t]-\hat{\psi}N_t\}\xi(N_t)k_t^a$. It also follows, as it can be readily seen from (30), that as long as $N_t < N_{t+1}$, next period capital will be given by a higher transition locus than that giving the current period capital. It follows that capital is moving along a rising trajectory, like the dotted line in Figure 4. Suppose, now, that while capital is at C, there is an increase in insiders influence, so that the new steady state is $\tilde{N}$, where $\tilde{N} < \bar{N}$. Clearly, since the steady state locus $\frac{a\beta}{1+g_A}(1-\hat{\psi}\bar{N})\xi(\bar{N})k^a$ is also an upper bound to all steady state loci, the new steady state locus, $\frac{a\beta}{1+g_A}(1-\hat{\psi}\tilde{N})\xi(\tilde{N})k^a$ is below the first. For a sufficient increase in insiders' power over government, point C maybe above the new steady state locus, $\frac{a\beta}{1+g_A}(1-\hat{\psi}\tilde{N})\xi(\tilde{N})k^a$. For precisely the same reasons like the ones used to establish the dotted trajectory, now capital will follow a falling trajectory, like the dashed trajectory from C to D, establishing the growth reversal in the case of a rising influence of insiders over government.

This growth reversal possibility serves as an explanation of what may have occurred in Greece. That is, the growth reversal observed in Figure 2 might be simply a consequence of the increasing influence of insiders in Greek society. In the model's framework, one may think of Greece, as a country with a low initial level of N, but with a progressively higher $1-\rho$, as insiders' influence over government grew stronger. Thus, about fourty years ago, the advent of the insiders-outsiders society in Greece, which was at a lower stage of development and was lacking adequate infrastructures, may have helped the economy to develop and grow. Precisely because, it led to the development of that infrastructure, when private provision of this infrastructure was poor or non-existing. But, eventually, the insiders-outsiders society may have exceeded its usefulness and insiders' unions enjoyed substantial wage premia, leading to labor misallocation and tax distortion and/or high debt, that caused the Greek crisis.[31] In fact, the overwhelming resistance and procrastination of public sector unions and practically all Greek governments in recent years in the implementation of the reforms requested by Greece's lenders incorporated in the various bailout programs (memorandum of understanding - "μνημόνια") can clearly be attributed to the very existence of the insiders-outsiders society as described in this paper.

An indication of the increase in the influence of insiders over government in Greece is the very high public sector wage premia as seen below in Figure 5.[32]

Figure 5: Public sector wage premium



Note: Data sources and definitions in the Appendix.

Also, credence to the validity of the model are the stylized facts reported in Figure 6. Namely, that wages in the public sector relative to the private sector are not only high but these wage differentials correlate negatively with general government employment over total employees, total factor productivity, and output growth.[33]

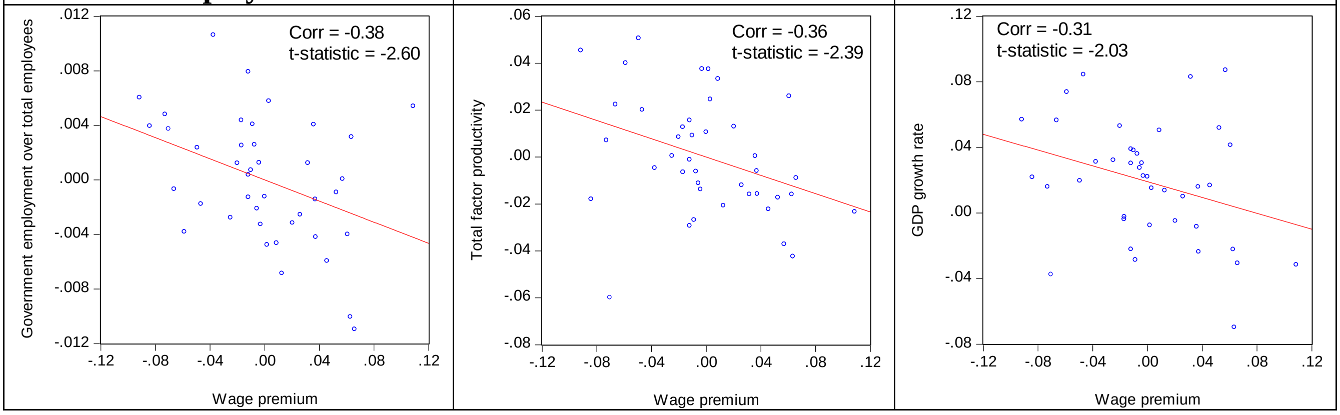
[31] A somewhat similar argument can be made for professional associations and the regulated prices and tax breaks they manage to get for their members. In a way, the present model can be readily modified to incorporate these professional associations. For example, treating a fixed number of professional associations as unions of intermediate good producers, that each one of them behaves like a monopolist in their respective market and all together cooperate so as to get tax breaks, results in a simplified version of our model, where, in the symmetric case, there is a fixed wage premium enjoyed by professional association members; and there is a tax rate gap between professional association members and the rest of society, that is increasing in the share of government spending over GDP.

[32] An even more dramatic picture would have emerged, if time series data on the average wage rate in public sector enterprises were available (which, to our knowledge, are not). This would be the case especially for Greece where circumstantial evidence (e.g., annual reports of the National Electric Power Company (ΔΕΗ)) suggests that wages in the public sector enterprises are considerably higher than average public sector wages.

[33] Also, recently, there have been several studies that show empirically that, not only Greece, but also Portugal, Spain, Italy, and Ireland exhibit higher public sector wage premia than other Euro Area countries. See, for example, Giordano et al. (2011), Campos and Centeno (2012)) and De Castro, et al. (2013)

Figure 6: Correlations with Public sector wage premium: Greece 1970-2010

Versus General Government Employment over Total Employees	Versus Total Factor Productivity	Versus Real per capita GDP Growth Rate



Note: Alll series with the exception of Real per capita GDP growth rate, have been detrended using the Hodrick Prescott filter with a smoothing parameter λ=100. Data sources and definitions in the Appendix.

First, the wage premium in the public sector is justified and related to union power, production technology, especially the degree of complementarity among publicly provided intermediate goods and the degree of government involvement in the economy, with the number of publicly provided intermediate goods thought to be a proxy of the latter (Proposition 1). Second, it provides for an explanation for the negative correlation between public sector wage premium and the ratio of public over total employment (Corollary 1). Third, it provides for an explanation for the negative correlation between public sector wage premium and after tax TFP (Proposition 3). Finally, the negative correlation between public sector wage premium and output growth can be decomposed into two parts: for a given country over time, it can be explained by growth reversal arguments similar to the ones discussed above, brought about by the advent of the insiders-outsiders society. And, for different countries, this negative correlation can be attributed to the degree their economies are characterized by the insiders-outsiders society. For example, one may think of Greece or other South European countries having very high λ and very high $1-\rho$, so that the threshold of N, in Proposition 3, is exceeded, while countries with very low or non-existent wage premia in the public sector, the Anglo-Saxon countries (except Australia before the millennium), for example, having very low λ and very low $1-\rho$, so that steady state N is below this threshold. For some other countries the model's structure may be altogether inappropriate. For example, the Nordic countries, where wage premia in the public sector are practically negligible, have very strong unions in both public and private sectors, but their unions co-operate to internalize the cost to the economy associated with a high wage premium in one industry or sector.[34] In our model's jargon this, practically means that outsiders behave like insiders and the Government of Insiders behaves like the Median Voter. All of these cases (as well as other questions, see, e.g., footnote 15),

[34] See European Commission (2013, 2014) and Kollintzas et al. (2015), for related country clusterings.

however, could be addressed by an extension of our model that incorporates a sector of privately provided intermediate goods and their corresponding unions, along the lines of Cole and Ohanian (2004).

5. CONCLUSIONS

In a synthesis of the insiders-outsiders labor market structure and the concept of an elite government, we constructed a dynamic general equilibrium model of market and political power interactions that can explain the growth reversal characterizing Greece in recent years. In this country public sector unions act independently in their respective markets, but co-operate to influence government policies, including those that affect public sector infrastructures. In so doing, they increase taxes and/or debt to inefficient levels. Moreover, the model is consistent with several stylized facts pertaining to the wage premium in the public sector, such as: the negative correlation between the public sector wage premium, on the one hand, and the ratio of public sector employment over total employment, total factor productivity, and output growth, on the other hand. Finally, this model may be of interest to understand growth performance in other developed or developing countries sharing similar institutional frictions with Greece.

ACKNOWLEDGEMENTS

We are grateful to Assar Lindbeck and Fabrice Collard for valuable comments. Dimitris Papageorgiou and Vanghelis Vassilatos gratefully acknowledge co-financing of this research by the European Union (European Social Fund — ESF) and Greek national funds through the Operational Program “Education and Lifelong Learning” of the National Strategic Reference Framework (NSRF) — Research Funding Program ARISTEIA II_Public Sector Reform, Research Grant, No 5328.

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APPENDIX

Proof of Proposition 2

Part a

Given Assumptions 1 and 2, $v(N)>1$, $\forall N\in\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$. Therefore, it follows from definition (18), that $\xi(N)>0$, $\forall N\in\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$. Fix $N=\bar{N}\in\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$ and consider ξ as a function of $\bar{v}=v(\bar{N})>1$. That is, let:

$$\xi(\bar{N})=\xi\left[v^{-1}(\bar{N})\right]\equiv\bar{\xi}(\bar{v})\equiv b^{b}(1-a-b)^{1-a-b}\Phi^{1-a-b}\bar{N}^{\frac{(1-a-b)(1-\zeta)}{\zeta}}\frac{\bar{v}^{b}}{\left[1-a-b+b\bar{v}\right]^{1-a}}$$

And, therefore, given Assumptions 1 and 2,

$$\left.\frac{\partial\xi}{\partial v}\right|_{N=\bar{N}}=\bar{\xi}'(\bar{v})=b^{b}(1-a-b)^{1-a-b}\Phi^{1-a-b}\bar{N}^{\frac{(1-a-b)(1-\zeta)}{\zeta}}\frac{(1-a-b)b\bar{v}^{b-1}(1-\bar{v})}{\left[1-a-b+b\bar{v}\right]^{2(1-a)}}<0\,.$$

Part b

Differentiate $\xi(N)$ with respect to N, to get:

$\xi'(N)=\xi(N)\dfrac{1-a-b}{N}\left\{\dfrac{1-\zeta}{\zeta}-\dfrac{bv'(N)N[v(N)-1]}{v(N)\left[1-a-b+bv(N_{t})\right]}\right\}$. And, since $v'(N)=\dfrac{\lambda(1-a-b-\zeta)v(N)^{2}}{N^{2}}$,

$$\xi'(N)=(1-a-b)\frac{\xi(N)}{N}\chi(N)\tag{A.2.1}$$

where:

$$\chi(N)=\frac{1-\zeta}{\zeta}-\frac{\lambda b(1-a-b-\zeta)v(N)\left[v(N)-1\right]}{N\left[1-a-b+bv(N)\right]}\tag{A.2.2}$$

Clearly, then, given Assumptions 1 and 2,

$\xi'(N)\overset{>}{\underset{<}{=}}0$ as $\chi(N)\overset{>}{\underset{<}{=}}0$, or as $\wp(N)\overset{<}{\underset{>}{=}}0$, where: $\wp(N)\equiv v(N)^{2}-[1+\hat{v}(N)]v(N)-\dfrac{1-a-b}{b}\hat{v}(N)$,

and, $\hat{v}(N)\equiv\dfrac{(1-\zeta)N}{\lambda\zeta(1-a-b-\zeta)}>0$. But, given Assumptions 1 and 2, $[1+\hat{v}(N)]>v(N)$, $\forall N\in\left(\dfrac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$. To see this, note that $v(N)=1$, for $N=\dfrac{1-\alpha-b-\zeta}{1-\zeta}$. And, by Proposition 1, it is strictly increasing, strictly concave, and approaches asymptotically $\dfrac{1}{1-\lambda(1-\zeta)}>1$, as $N\rightarrow\infty$. On the other hand, $[1+\hat{v}(N)]$ is $1+\dfrac{1}{\lambda\zeta}>\dfrac{1}{1-\lambda(1-\zeta)}$ for

$N=\frac{1-\alpha-b-\zeta}{1-\zeta}$ and increases at a constant rate, throughout $\left(\frac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$. Therefore, given Assumptions 1 and 2, $\wp(N)<0$, $\forall N\in\left(\frac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$ and hence $\xi'(N)>0$, $\forall N\in\left(\frac{1-\alpha-b-\zeta}{1-\zeta},\infty\right)$.

Q.E.D.

Proof of Proposition 3

Note that:

$$\frac{d(1-\hat{\psi}N)\xi(N)}{dN}\overset{>}{\underset{<}{=}}0 \text{ as } \frac{\xi'(N)\xi(N)}{\xi(N)}\overset{>}{\underset{<}{=}}\frac{\hat{\psi}N}{1-\hat{\psi}N}$$

Therefore, in view of (A.2.1) and (A.2.2), we have:

$$\frac{d(1-\hat{\psi}N)\xi(N)}{dN}\overset{>}{\underset{<}{=}}0 \text{ as } \Re\left[v(N),N\right]\overset{<}{\underset{>}{=}}0$$

where

$$\Re\left[v(N),N\right]\equiv v(N)^2-\left[1+\tilde{v}(N)\right]v(N)-\frac{1-a-b}{b}\tilde{v}(N)$$

and

$$\tilde{v}(N)\equiv\left[\frac{1-\zeta}{\zeta}-\frac{\hat{\psi}N}{(1-a-b)(1-\hat{\psi}N)}\right]\frac{\hat{\psi}N}{\lambda\hat{\psi}(1-a-b-\zeta)}$$

Given Assumptions 1 and 2, $0<\frac{1-\alpha-b-\zeta}{1-\zeta}<1$ and in view of the facts that $\tau=\hat{\psi}N$ and $0<\tau\leq 1$, N is restricted to be in the interval $\mathbf{N}_1\equiv\left(\underline{N}_1,\overline{N}_1\right)\equiv\left(\frac{1-\alpha-b-\zeta}{1-\zeta},\frac{1}{\hat{\psi}}\right)$. Note, then, that if $N\in\mathbf{N}_2\equiv\left[\underline{N}_2,\overline{N}_2\right)\equiv\left[\frac{(1-a-b)(1-\zeta)}{\hat{\psi}\left[(1-a-b)(1-\zeta)+\zeta\right]},\frac{1}{\hat{\psi}}\right)$, $\tilde{v}(N)\leq 0$. And, since Assumptions 1 and 2 imply that $v(N)\geq 1,\forall N\in\mathbf{N}_1$, it follows that $\Re\left[v(N),N\right]>0$, $\forall N\in\mathbf{N}_1\cap\mathbf{N}_2=\left[\max\left\{\underline{N}_1,\underline{N}_2\right\},\overline{N}_2\right)$. Hence, $\frac{d(1-\hat{\psi}N)\xi(N)}{dN}<0$, $\forall N\in\mathbf{N}_1\cap\mathbf{N}_2$. Further, observe that if $\underline{N}_2\leq\underline{N}_1$, $\mathbf{N}_1\cap\mathbf{N}_2=\mathbf{N}_1$ and there is no other case left to consider. Thus, suppose that $\underline{N}_2>\underline{N}_1$ and consider the case where

$N \in \mathbf{N}_3 \equiv (\underline{N}_3, \overline{N}_3) = (\underline{N}_1, \underline{N}_2)$. Clearly, in this case $\tilde{v}(N) > 0$, $\forall N \in \mathbf{N}_3$. It follows that $\Re[v(N), N]$ may be factored as follows:

$$\Re[v(N), N] = [v(N) - \overline{v}(N)][v(N) - \underline{v}(N)]$$

where $\underline{v}(N)$, $\overline{v}(N) : \mathbf{N}_3 \to \mathbb{R}$, such that:

$$-\underline{v}(N),\ \overline{v}(N) > 0$$

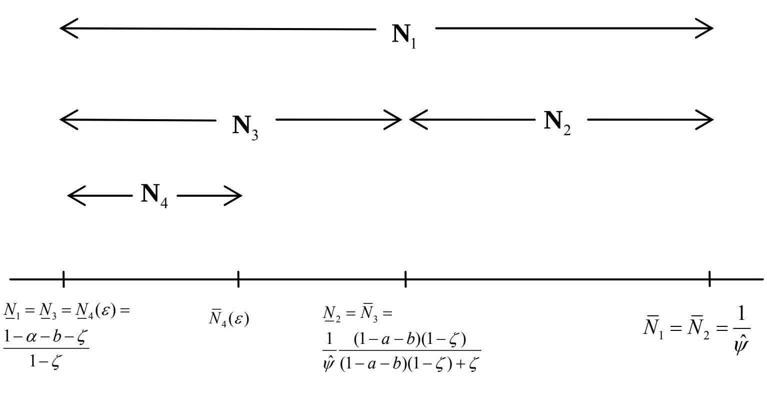
$$\underline{v}(N)\overline{v}(N) = \frac{1-\alpha-b}{b}\tilde{v}(N) < 0$$

Therefore, $\Re[v(N), N] < 0$, for all $N \in \mathbf{N}_3$, if and only if $1 \le v(N) < \tilde{v}(N)$, for all $N \in \mathbf{N}_3$.

In this case, of course, $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} > 0$, $\forall N \in \mathbf{N}_3$. To complete the proof, it suffices to show that there exists a non-empty sub-interval of $\mathbf{N}_3$ such that $1 \le v(N) < \overline{v}(N)$. To show this, first observe that $1 \le v(N) < \overline{v}(N)$, $\forall N \in \mathbf{N}_3$, if and only if $1 \le v(N) < 1 + \tilde{v}(N) + \varepsilon$, $\forall N \in \mathbf{N}_3$, where $0 < \varepsilon < \sup[-\underline{v}(N)]$. Recall that $v(N) : \mathbf{N}_1 \to (1, v(\overline{N}_1))$ is strictly increasing throughout its domain and $v(\underline{N}_1) = v(\underline{N}_3) = 1$. Consider, now, any sufficiently small $\varepsilon \in \left(0, \sup_{N \in \mathbf{N}_3}[-\underline{v}(N)]\right)$ and observe that there exists a $\overline{N}_4(\varepsilon) \in \mathbf{N}_3$ and $\overline{N}_4(\varepsilon) > \underline{N}_3$ such that $v(\overline{N}_4(\varepsilon)) = 1 + \varepsilon$. Clearly, then, $1 \le v(N) < 1 + \tilde{v}(N) + \varepsilon$ for all $N \in \mathbf{N}_4(\varepsilon) \equiv (\underline{N}_4(\varepsilon), \overline{N}_4(\varepsilon)) = (\underline{N}_3, v^{-1}(1+\varepsilon)) \subset \mathbf{N}_3$ (See Figure A.1).

Q.E.D.

Figure A.1: An illustration of the sub-interval of $\mathbf{N}_1$, where $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} < 0$, $\mathbf{N}_2$, and the sub-interval of $\mathbf{N}_1$, where $\frac{d(1-\hat{\psi}N)\xi(N)}{dN} > 0$, $\mathbf{N}_4(\varepsilon)$.



Proof of Proposition 4

Part a

The Euler – Lagrange conditions associated with the Hybrid politicoeconomic equilibrium are given by:

$$\begin{aligned}&\left[\rho\alpha\beta+(1-\rho)\alpha\beta\lambda\right]k_{t+1}^{-1}-\mu_t\,(1+g_A)+\\&a\beta\mu_{t+1}\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\xi(N_{t+1})k_{t+1}^{a}=0\end{aligned}\tag{A.4.1}$$

and

$$\begin{aligned}&-\beta^{-1}\rho\tilde{\psi}\left[1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t\right]^{-1}+\\&\rho\left\{(\tilde{\psi}-\hat{\psi})+\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\right\}\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]^{-1}+\\&\lambda(1-\rho)\left[\frac{\upsilon'(N_{t+1})}{\upsilon(N_{t+1})}+\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\right]-\beta^{-1}\mu_t\,a\beta\tilde{\psi}\xi(N_t)k_t^{a}+\\&\mu_{t+1}a\beta\left\{(\tilde{\psi}-\hat{\psi})+\left[1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}\right]\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}\right\}\xi(N_{t+1})k_{t+1}^{a}=0\end{aligned}\tag{A.4.2}$$

where μ_t is the Lagrange multiplier associated with (20).

In view of (20), (A.5.1) can be rewritten as:

$$\mu_t(1+g_A)k_{t+1}=\left[\rho\alpha\beta+(1-\rho)\alpha\beta\lambda\right]+a\beta\mu_{t+1}(1+g_A)k_{t+2}=0\tag{A.4.3}$$

Solving (A.5.3) forward and provided that $\lim_{u\to\infty}(a\beta)^u\mu_{t+u}(1+g_A)k_{t+u+1}=0$ gives:

$$\mu_t(1+g_A)k_{t+1}=\frac{\rho\alpha\beta+(1-\rho)\alpha\beta\lambda}{1-a\beta}\tag{A.4.4}$$

We verify that (A.5.4) satisfies $\lim_{u\to\infty}(a\beta)^u\mu_{t+u}(1+g_A)k_{t+u+1}=\frac{\rho\alpha\beta+(1-\rho)\alpha\beta\lambda}{1-a\beta}\lim_{u\to\infty}(a\beta)^u=0$, since $a,\beta\in(0,1)$.

Therefore,

$$\mu_t=\frac{\rho\alpha\beta+(1-\rho)\alpha\beta\lambda}{(1-a\beta)(1+g_A)k_{t+1}}\tag{A.4.5}$$

Then, in view of (A.5.5), (A.5.2) gives:

$$\varphi(N_{t+1})=\frac{\beta^{-1}\tilde{\psi}}{1-\tilde{\psi}(N_{t+1}-N_t)-\hat{\psi}N_t}-\frac{\tilde{\psi}-\hat{\psi}}{1-\tilde{\psi}(N_{t+2}-N_{t+1})-\hat{\psi}N_{t+1}};\tag{A.4.6}$$

where

$$\varphi\;(N_{t+1})=A\frac{\xi'(N_{t+1})}{\xi(N_{t+1})}+B\frac{\upsilon'(N_{t+1})}{\upsilon(N_{t+1})};\tag{A.4.7}$$

with

$$(A,B)=(\frac{\rho+\lambda(1-\rho)}{\rho+\alpha\beta\lambda(1-\rho)},\frac{(1-\alpha\beta)\lambda(1-\rho)}{\rho+\alpha\beta\lambda(1-\rho)}) \ . \tag{A.4.8}$$

Part b

Let any steady state defined by:

$...=k_{t-1}=k_t=k_{t+1}=...=k^{\rho};$

$...=N_{t-1}=N_t=N_{t+1}=...=N^{\rho}.$

It follows from (20) and (A.5.6) that any steady state must satisfy:

$$k^{\rho}=\left[\frac{a\beta(1-\hat{\psi}N^{\rho})\xi(N^{\rho})}{1+g_A}\right]^{\frac{1}{1-a}} \tag{A.4.9}$$

and

$$(1-\hat{\psi}N^{\rho})\varphi^{\rho}(N^{\rho})=(\beta^{-1}-1)\tilde{\psi}+\hat{\psi} \tag{A.4.10}$$

To prove the existence and uniqueness of the steady state, first note that the RHS of (A.4.10) is a positive constant, $(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}$ and the LHS in this equality is $(1-\hat{\psi}N)\ \varphi(N)=\ A(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}+B(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}$,where $A>0$ and $B\geq 0$, with $B=0$ if and only if $\rho=1$. Consider first the function $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$. It was shown in the proof of Proposition 2, that, given Assumptions 1 and 2,

$$(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}=(1-a-b)(1-\hat{\psi}N)\left\{\frac{1-\zeta}{\zeta N}-\frac{bv'(N)[v(N)-1]}{v(N)\left[1-a-b+bv(N)\right]}\right\}>0\,,\forall N\in\mathbf{N}_1 \tag{A.4.11}$$

Further, recall from Proposition 1 that, given Assumptions 1 and 2: $v'(N_t)=\frac{\lambda(1-a-b-\zeta)\left[v(N_t)\right]^2}{N_t^{\,2}}>0$, $v''(N_t)=\frac{-2\lambda(1-a-b-\zeta)\left[1-\lambda(1-\zeta)\right]\left[v(N_t)\right]^3}{N_t^{\,3}}<0$, and $v(N''')=\frac{6\lambda(1-a-b-\zeta)\left[1-\lambda(1-\zeta)\right]^2 v(N)^4}{N^4}>0$. Also, recall from Proposition 2,that given Assumptions 1 and 2,

$(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}\rightarrow\frac{(1-a-b)(1-\zeta)^2}{(1-a-b-\zeta)\zeta}\left(1-\hat{\psi}\,\frac{1-\alpha-b-\zeta}{1-\zeta}\right)>0$, as $N\rightarrow\underline{N}_1$ and $(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}\rightarrow 0$ as $N\rightarrow\overline{N}_1$. Next, consider, the function $(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}$, where $\upsilon(N)=\frac{\left[v(N)-1\right]}{v(N_t)\left[1-a-b+bv(N)\right]^{(1-\lambda)/\lambda}}$. It follows that:

$$(1-\hat{\psi}N)\,\frac{\upsilon'(N)}{\upsilon(N)}=\frac{\lambda(1-a-b-\zeta)v(N)^2}{N^2}(1-\hat{\psi}N)\left\{\frac{1}{v(N)[v(N)-1]}-\frac{(1-\lambda)b}{\lambda\left[1-a-b+bv(N)\right]}\right\} \qquad \text{(A.4.12)}$$

Using the above stated properties of $v(N)$, it follows by tedious but otherwise straightforward algebra, that given Assumptions 1 and 2, $\frac{d\left[\xi'(N)/\xi(N)\right]}{dN}<0$, $\frac{d^2\left[\xi'(N)/\xi(N)\right]}{dN^2}>0$, $\frac{\upsilon'(N)}{\upsilon(N)}>0$, $\frac{d\left[\upsilon'(N)/\upsilon(N)\right]}{dN}<0$, $\frac{d^2\left[\upsilon'(N)/\upsilon(N)\right]}{dN^2}>0\ \forall N\in\left(\underline{N}_1,\bar{N}_1\right)$. Furthermore, it follows from (A.5.12) that $(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}\rightarrow+\infty$ as $N\rightarrow\underline{N}_1$ and $(1-\hat{\psi}N)\frac{\upsilon'(N)}{\upsilon(N)}\rightarrow 0$ as $N\rightarrow\bar{N}_1$. Combining results, it follows that: $(1-\hat{\psi}N)\varphi(N)>0$,$\frac{d[(1-\hat{\psi}N)\varphi(N)]}{dN}<0$, $\frac{d^2[(1-\hat{\psi}N)\varphi(N)]}{dN^2}>0\ \forall N\in\left(\underline{N}_1,\bar{N}_1\right)$. Moreover, $(1-\hat{\psi}N)\varphi(N)\rightarrow 0$ as $N\rightarrow\bar{N}_1$. Furthermore, as long as $\rho<1$, $(1-\hat{\psi}N)\varphi(N)\rightarrow+\infty$ as $N\rightarrow\underline{N}_1$; and when $\rho=1$, in which case $(1-\hat{\psi}N)\varphi(N)=(1-\hat{\psi}N)\frac{\xi'(N)}{\xi(N)}$, Assumption 3 implies that $(1-\hat{\psi}N)\varphi(N)\rightarrow\frac{(1-a-b)(1-\zeta)^2}{(1-a-b-\zeta)\zeta}(1-\hat{\psi}\frac{1-\alpha-b-\zeta}{1-\zeta})>(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}$ as $N\rightarrow\underline{N}_1$. Hence, under the stated assumptions, $(1-\hat{\psi}N)\varphi(N)$ is continuous, positive, strictly decreasing and strictly concave, $\forall N\in\left(\underline{N}_1,\bar{N}_1\right)$. Further it takes a value greater than, $[(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}]>0$ as $N\rightarrow\underline{N}_1$; and takes the value 0, as $N\rightarrow\bar{N}_1$. Therefore, $(1-\hat{\psi}N)\varphi(N)$ takes the value $(\beta^{-1}-1)\tilde{\psi}+\hat{\psi}$ at a unique point in the open interval $\left(\underline{N}_1,\bar{N}_1\right)$, N^{ρ}. And, therefore, $k^{\rho}\in(0,\infty)$, defined by (A.4.9), is also unique.

Part c

Note that ρ affects $(1-\hat{\psi}N)\varphi(N)$ only through A and B. Then, since both of these constants are strictly decreasing functions of ρ and $(1-\hat{\psi}N)\varphi(N)$ is strictly increasing in both *A* and *B,* it is immediate from Part b, that an increase in $1-\rho$ increases the steady state value of value of *N*, N^{ρ}.

Q.E.D.

Proof of Proposition 5

Let:

$$h\left(N_t, N_{t+1}, N_{t+2}\right) \equiv \varphi\left(N_{t+1}\right) - \frac{\beta^{-1}\tilde{\psi}}{1-\tilde{\psi}\left(N_{t+1}-N_t\right)-\hat{\psi}N_t} + \frac{\tilde{\psi}-\hat{\psi}}{1-\tilde{\psi}\left(N_{t+2}-N_{t+1}\right)-\hat{\psi}N_{t+1}} \tag{A.5.1}$$

Then,

$$h\left(N_t, N_{t+1}, N_{t+2}\right) = 0 \tag{A.5.2}$$

is equivalent to (A.4.6). And,

$$h\left(N, N, N\right) = 0 \tag{A.5.3}$$

is equivalent to (A.4.10).

Taking a first order approximation of $h\left(N_t, N_{t+1}, N_{t+2}\right)$ around $h\left(N, N, N\right)$, we have:

$$\begin{aligned} &h\left(N_t, N_{t+1}, N_{t+2}\right) \simeq h\left(N, N, N\right) + \\ &\quad h_3\left(N, N, N\right)\left(N_{t+2}-N\right) + h_2\left(N, N, N\right)\left(N_{t+1}-N\right) + h_1\left(N, N, N\right)\left(N_t - N\right) = 0 \end{aligned} \tag{A.5.4}$$

where $h_i\left(N, N, N\right)$, $i = \left(1,2,3\right)$ denote the partial derivatives of *h* with respect to its first, second and third argument, respectively, evaluated at $\left(N, N, N\right)$. In view of (A.5.3), (A.5.4) yields:

$$\begin{aligned} &\frac{\tilde{\psi}\left(\tilde{\psi}-\hat{\psi}\right)}{\left(1-\hat{\psi}N\right)^2}\left(N_{t+2}-N\right) - \left[\frac{\beta^{-1}\tilde{\psi}^2}{\left(1-\hat{\psi}N\right)^2} + \frac{\left(\tilde{\psi}-\hat{\psi}\right)^2}{\left(1-\hat{\psi}N\right)^2} - \varphi'(N)\right]\left(N_{t+1}-N\right) + \\ &\beta^{-1}\frac{\tilde{\psi}\left(\tilde{\psi}-\hat{\psi}\right)}{\left(1-\hat{\psi}N\right)^2}\left(N_t - N\right) = 0 \end{aligned} \tag{A.5.5}$$

It follows that the characteristic equation associated with (A.5.5) is:

$$\sigma^2 - \left[\frac{\beta^{-1}\tilde{\psi}}{\tilde{\psi}-\hat{\psi}} + \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}} - \frac{\left(1-\hat{\psi}N\right)^2}{\tilde{\psi}\left(\tilde{\psi}-\hat{\psi}\right)}\varphi'(N)\right]\sigma + \beta^{-1} = 0$$

This equation has two roots, $\sigma \in \left(0, \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}}\right) \subset (0,1)$ and $(\sigma\beta)^{-1} > 1$. Then, since N_t is restricted to be in the interval $\left(\frac{1-\alpha-b-\zeta}{1-\zeta}, \frac{1}{\hat{\psi}}\right)$, the unique solution of (A.5.5) is given by:

$$N_{t+1} - N = \sigma\left(N_t - N\right) \tag{A.5.6}$$

where:

$$\sigma = \frac{1}{2}\left[\left[\frac{\beta^{-1}\tilde{\psi}}{\tilde{\psi}-\hat{\psi}} + \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}} - \frac{\left(1-\hat{\psi}N\right)^2}{\tilde{\psi}\left(\tilde{\psi}-\hat{\psi}\right)}\varphi'(N)\right] - \left\{\left[\frac{\beta^{-1}\tilde{\psi}}{\tilde{\psi}-\hat{\psi}} + \frac{\tilde{\psi}-\hat{\psi}}{\tilde{\psi}} - \frac{\left(1-\hat{\psi}N\right)^2}{\tilde{\psi}\left(\tilde{\psi}-\hat{\psi}\right)}\varphi'(N)\right]^2 - 4\beta^{-1}\right\}^{1/2}\right]$$

Q.E.D.

DATA APPENDIX

The data set includes twenty-one OECD individual countries (Australia, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Israel, Korea, Netherlands, Portugal, Spain, Canada, Japan, Norway, Sweden, UK and US.), as well as time series for total OECD countries and Euro area-19 countries. Data are yearly and cover a maximum time span from 1970 to 2010. Our main data source is the OECD Economic Outlook no. 90. Missing values for some specific time periods/variables have been completed from the OECD Economic Outlook no. 88, 86, 85 and AMECO. Other data sources are the OECD Aggregate National Accounts and OECD.stats.

Variable	**Source**
Real Gross Domestic Product (per head, constant prices, constant PPPs)	OECD.stat
Total compensation of employees	OECD Economic Outlook and OECD Aggregate National Accounts
Government final wage consumption expenditure[1]	OECD Economic Outlook and AMECO
Dependent employment - Total economy (Total employees)[2]	OECD Economic Outlook
Dependent employment in the private sector (Private sector employees)[2]	OECD Economic Outlook
General government employment[3]	OECD Economic Outlook
Total compensation of employees in the private sector	Own calculations (Total compensation of employees minus government final wage consumption expenditure)
Compensation rate in the private sector	Own calculations (Total compensation of employees in the private sector divided by private sector employees)
Compensation rate in the public sector	Own calculations (Government final wage consumption expenditure divided by government employment)
Public sector wage premium	Own calculations (Compensation rate in the public sector divided by the compensation rate in the private sector)
Total factor productivity-Total economy	AMECO
Output gap	Own calculations (Gap between Real GDP in PPP values and Hodrick-Prescott trend divided by H-P filter)
Real Gross Domestic Product - Greece	AMECO
Population 15-64 - Greece	OECD Economic Outlook

Notes:

1. For Australia, government final wage consumption is computed as $CGW = WSSS - WSSE * EEP$, where $WSSS$ is total compensation of employees, $WSSE$ is the compensation rate in the private sector and EEP is dependent employment in the private sector.

2. For Germany and Korea, total dependent employment, EE, and dependent employment in the private sector, EEP, are respectively computed from the following relationships: $WSST = WSSS / EE$ and $WSSE = (WSSS - GCW) / EEP$, where $WSST$ is the compensation rate of the total economy, $WSSE$ is the compensation rate in the private sector, $WSSS$ is total compensation of employees, and GCW is government final wage consumption expenditure. For Israel, EE is computed as $EE = ET - ES$,

where ET is total employment and ES is total self-employment. Then, EEP is computed as $EEP = EE - GE$, where GE is general government employment.

3. For Australia, Austria, Germany and Korea, general government employment is computed as $GE = EE - EEP$, where EE is total dependent employment and EEP is dependent employment in the private sector. For Greece, to compute the number of general government employees we use updated data from the Ministry of Administrative Reform and Electronic Governance that recently provided accurate measures for the number of public sector employees in Greece since 2009. In particular, we compute the number of general government employees for the period 2009-2010 as the sum of permanent employees in the public sector plus the number of employees in private legal entities of the general government. To obtain time series prior to 2009, we assume that government employment follows the growth pattern of the time series from the OECD database. Then, the number of private sector employees is computed as $EEP = EE - GE$. Note that the number of general government employees is revised upwards as compared to the number of employees provided by the OECD database since there is a reallocation of the number of employees in the private and general government sectors.

Figure A2. Greece and Euro Area-19 countries (1995-2014)